EIGHTEENTH REPORT

OF THE

STATE BOARD OF HEALTH

AND VITAL STATISTICS

OF

MINNESOTA, 1899-1900.

ST. PAUL, MINN.,
PIONEER PRESS COMPANY.
1901.

MEMBERS OF THE STATE BOARD OF HEALTH AND VITAL STATISTICS, 1900.

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HENRY M. BRACKEN, M. D., Sec. and Ex. Officer.	Minneapolis

Office of the State Board of Health and Vital Statistics,
St. Paul, Minn., Dec. 31, 1900.

To His Excellency John Lind, Governor,

Sir:—The State Board of Health herewith respectfully submits its report for the twenty-eighth and twenty-ninth years of its existence, embracing the period from Dec. 31, 1898, to Dec. 31, 1900.

H. M. BRACKEN, M. D.,
Secretary and Executive Officer.

MINUTES OF THE

REGULAR QUARTERLY MEETINGS

OF THE

MINNESOTA STATE BOARD OF HEALTH.

Jan. 10, 1899.

The meeting was called to order by the president, Dr. Franklin Staples.

Roll call: Present—Drs. Staples, Hutchinson, Wesbrook, Reynolds, McComb, Greene and Bracken.

The minutes of the previous meeting were read and approved.

Election of officers resulted as follows:

President—Dr. Franklin Staples, Winona.

Vice President—Dr. Henry Hutchinson, St. Paul.

Director of Bacteriological Laboratory—Dr. F. F. Wesbrook, Minneapolis.

Director of Veterinary Department—Dr. M. H. Reynolds, St. Anthony Park.

Under unfinished business, reports were made as follows:

Concerning action relating to leprosy, not only in Minnesota but in the United States, the secretary reported consultation with the leprologists of the state, as directed at the meeting of April, 1898, viz., Drs. Boeckmann, Hoegh, Foster and Vander Horck, who met with Drs. Hutchinson, Wesbrook and Bracken, of the executive committee. No definite action taken, but work to be continued.

The various reports from the executive officer and directors of the bacteriological laboratory and veterinary department, previously sent to each member of the board for perusal, were approved without reading. The various topics presented in them for action were taken up as follows:

Biennial Report: The secretary stated that the reports for the past four years were in press. It had been expected that these

reports would have been completed in December, but this had been impossible.

Inspection of Schools: Dr. Greene presented a motion that all school children be subjected to a monthly inspection, in order to guard against infectious diseases. Referred to executive committee.

The question of the state board passing upon the fitness of local health officers, before their appointment was completed, was presented in Dr. Wesbrook's report, but no action taken.

The question of using only the bacteriological findings by which to regulate the quarantine of diphtheria was referred to the executive committee for further consideration and recommendation.

The question raised by Dr. Wesbrook as to the publication of work done in the laboratory, by papers or exclusively in official reports, was discussed to some extent. The unanimous sentiment was in favor of publishing, in current periodicals or through associations, all work done by the board, at as early a date as possible, thus keeping before medical and sanitary workers the results of this board's work.

The question bearing upon experiments with disinfectants was, on motion, referred to the executive committee.

Relating to a report from the laboratory bearing upon work done at Camp Ramsey, Dr. Wesbrook requested and was given permission to use his reports presented at the last two quarterly meetings of this board to secure material for same.

Dr. Bracken moved that the veterinary department be instructed to make an annual examination for tuberculosis of cattle at state institutions. Seconded by Dr. Greene. Carried.

Dr. Bracken moved that matters pertaining to legislation be referred to the executive committee, with power to act. Seconded by Dr. McComb. Carried.

Dr. McComb moved that the officers of the board and directors of departments constitute the executive committee. Motion seconded and carried.

Dr. Bracken moved that the last quarterly report be published as a supplement to the biennial reports now in press. Motion seconded and carried.

On adjournment, the board as a body visited the capitol to pay its respects to Governor Lind.

H. M. BRACKEN, M. D.,
Secretary and Executive Officer.

April 11, 1899.

The meeting was called to order by Dr. Henry Hutchinson, vice president, at 11:45 a. m., it having been impossible, for lack of a quorum, to take such action earlier, although the meeting was called for the hour set by law, viz., 10 a. m.

Dr. Staples was not able to be present on account of poor health. Dr. Nissen telegraphed that it would be impossible for him to attend. Dr. Mayo was absent from the state. From Dr. McComb there was no word.

Roll call: Present—Drs. Hutchinson, Greene, Wesbrook, Reynolds and Bracken.

The minutes of the previous meeting were read and approved.

New Business: Inspection of Schools—The feasibility of devising some practical scheme by which to reach infectious diseases through the aid of the public schools was, by motion of Dr. Bracken, referred to the executive committee, to be reported upon at the next regular meeting. Motion seconded and carried.

It was moved by Dr. Greene, that the request of Dr. Wesbrook, that the laboratory be permitted to put in form a short printed circular relating to the presence of *bacillus diphtheriae* in children not presenting clinical symptoms, for presentation to laboratories throughout this continent and Europe, for comparison and further study be granted. Motion seconded and carried.

Dr. Greene moved that the compilation of a circular, for use by local health officers and others, upon disinfectants, be referred to the executive committee, the same to report at the next meeting. Motion seconded and carried.

Dr. Greene moved that the suggestion of the secretary, that all cases of cerebro-spinal meningitis should be reported to this board by physicians or local health officers, be referred to the executive committee, in order that some plan should be formulated and reported upon at our next meeting; also, that a circular setting forth certain prophylactic measures be prepared. Motion seconded and carried.

Dr. Greene moved that the suggestions set forth in the report of the secretary, relating to the transportation of the dead, be adopted. Motion seconded and carried.

These suggestions were that the clause in rule 4, requiring that bodies shipped must reach their destination within thirty hours from time of death unless specially prepared, be amended to "forty-eight" hours, from April 1st to September 30th, inclusive, and "seventy-two" hours from October 1st to March 31st, inclusive. This

amendment can apply only to bodies shipped from point to point in this state (Minnesota). Motion seconded and carried.

At 12:30 the board took a recess of one hour for luncheon.

Dr. Hutchinson was taken ill during the luncheon hour. Dr. Greene attended Dr. Hutchinson to his home about 3 p. m., and was with him for some time following. It was therefore impossible to continue business, as only three members of the board were present. Drs. Wesbrook, Reynolds and Bracken talked over matters in an informal way until 5 p. m.

H. M. BRACKEN, M. D.,
Secretary and Executive Officer.

July 11, 1899.

The meeting was called to order at 2:40 p. m., it having been impossible to secure a quorum before that time.

A letter having been received from Dr. Staples, the president, stating that he would be unable to attend, Dr. Henry Hutchinson the vice president, presided.

Roll call: Present—Drs. Henry Hutchinson, Henrik Nissen, C. L. Greene, F. F. Wesbrook, M. H. Reynolds and H. M. Bracken.

The minutes of the previous meeting were read and approved.

Unfinished Business: The following subjects, referred to the executive committee at the last meeting for reports, to be presented at this meeting, were carried forward.

1. The possibility of devising some practical scheme by which to secure aid through the public schools in controlling the spread of infectious diseases.

2. The compilation of a circular upon disinfectants, to serve as a guide for local health officers in performing their duties.

3. Arranging for the reporting of all cases of cerebro-spinal meningitis to this office, either by attending physicians or by local health officers.

New Business: From Bacteriological Laboratory—In connection with Dr. Wesbrook's report, Dr. Bracken moved that the methods of further investigation into the ætiology of malignant catarrh in cattle be referred to the executive committee. Motion carried.

Dr. Greene moved that the desirability of issuing a circular, to be sent to local health officers in those districts where rabies has been reported to have occurred, advising them that all such animals should be secured and kept under observation until a veterinary

diagnosis can be made, if possible; advising, also, as to what should be done in case the animal has already been killed, in order to secure a diagnosis from the state board of health laboratory; advising, also as to what should be done with animals and persons bitten by an animal suspected of having rabies,—be referred to the executive committee to report at next meeting. Motion carried.

The question of the purchase of animals for research work, and the determining of which fund should pay for same, was referred to the executive committee.

From Veterinary Department: Upon Dr. Reynolds' explanation of the quarantine of the glandered horses of Mr. Peterson, in Mounds View township, Ramsey county, and the facts relating thereto, it was decded to take no legal action against Mr. Peterson, but to let the matter rest where it now is, provided there is no further complaint in the case.

In regard to the branding of cattle undergoing inspection (or after inspection) for tuberculosis, it was moved by Dr. Bracken, that the official branding or tagging of cattle, tested with tuberculin, be referred to the executive committee for final action. Motion carried.

The formation of rules relating to sheep scab and quarantine regulations for same was, on motion of Dr. Bracken, referred to the executive committee. Motion carried.

Dr. Reynolds stated that at times it might be necessary to employ a veterinarian not in our regular employ, on short notice, and wanted to know how it could be done. It was the sense of the board that the executive officer had authority to meet such emergencies.

Dr. Reynolds requested permission to attend the regular meeting of the American Veterinary Association at New York. Permission granted, necessary expenses of the trip to be paid.

The following resolution was adopted by the board:

In view of the fact that the special license granted to embalmers by this and other states is for the purpose of allowing the shipment of the remains of those who have died of a communicable disease, also of shipping of remains for a considerable distance, and that such permission should only be granted to such embalmers as have demonstrated their fitness for such duties; therefore, be it

Resolved, That the state board of health of Minnesota will only recognize such special shipping permits from other states as shall come from embalmers who have been granted a license after a careful examination by a responsible licensing board recognized by this state board of health.

The following was referred to the executive committee, with power to act.

In view of the fact that smallpox is prevailing to so great an extent throughout the country, and that the danger from infection will be increased as cold weather comes on, it is advisable that this board direct all schools, at the fall opening, to require a certificate of vaccination before admitting a pupil.

The following resolution was adopted by the board:

In view of the fact that infectious diseases are more prevalent during the winter than summer; that the schools are the frequent source of infection; that it is to the interests of the schools, as well as the public at large, to exclude infectious diseases so far as possible from the school room; therefore, be it

Resolved, That the Minnesota state board of health make a special effort to secure the aid of all teachers in detecting and excluding children suffering from infectious diseases from the schools; that the board express itself as willing to give instructions, by lectures or otherwise, to teachers, at summer schools, normal schools, or other places where teachers meet together, in the methods of recognizing infectious diseases in their early stages, thus aiding them in becoming active sanitarians.

The following suggestion of the secretary was referred to the executive committee, with power to act:

In view of the fact that it is a common custom for the small cities and villages to establish water plants and sewerage systems without much regard to sanitation; therefore, be it

Resolved, That this board, acting under authority of the law relating to the pollution of rivers and sources of water supply, draw up rules governing the establishment of water supplies and sewerage systems throughout the state, as well as the discharge of water from creameries, slaughter houses, tanneries, factories, etc.

The following suggestion of the secretary was referred to the executive committee, with power to act:

Resolved, That the executive committee be instructed to take such action as it may see fit, looking to the examination of water supplies for drinking purposes, such work to extend over the next three months, to be reported upon at our next meeting.

The following suggestion of the secretary was referred to the executive committee, with power to act:

In order to protect the public against possible danger, as well as to prevent the concealment of crime, it is advisable that, so far as practical, a burial permit be required for all burials throughout the state, and that no disinterment be allowed without a special permit from the local board of

health when under the jurisdiction of a physician, and from the state board of health for country districts where there is no medical health officer.

The following suggestion of the secretary was adopted, by motion:

In view of the fact that Illinois, Pennsylvania and many other states have taken steps to prevent the importation of cattle for dairy purposes that have not passed the tuberculin test, and also that the larger cities are demanding a certificate showing that dairy cattle are free from tuberculosis, it is desirable that this board notify the breeders and dairymen throughout the state to the effect that if they will secure inspection at their own expense, under our supervision, and will keep their herds in good sanitary condition, we will grant them a certificate indorsing the good character of their dairies. Such a plan has been tried in Indiana, and has been found to work favorably.

By motion, the secretary was authorized to employ a competent agent to examine rendering establishments through the state prior to issuance of license to them, as prescribed by the last legislature.

Recommendations of the executive committee meeting, July 10, 1899:

That an inspector be employed to look after the quarantine of domestic animals, chiefly about the two cities; that such inspector shall receive not to exceed $100 per month, he to furnish his own transportation from place to place and to pay his own expenses. That the above inspector shall be in the employ of the state board of health, and subject only to instructions of its representatives, but that in consideration of this work being done in part for the benefit of the two cities, St. Paul and Minneapolis, they be invited to pay each one-fourth of the monthly wages, the state board of health proportion (one-half) to be paid out of the veterinary fund.

By motion, the above recommendation was approved and granted.

Dr. Reynolds was requested to secure, if possible, a pledge from the two cities, as suggested above, and to report results to the executive committee at its next meeting.

Mr. W. J. Pomplum received the nomination from Dr. Reynolds to act as such inspector, and his nomination was approved.

Dr. Reynolds recommended that rule 2, relating to the work of the veterinary department, be altered to read as follows, instead of as at present.

The director shall conduct the correspondence dealing exclusively with veterinary matters, and he shall have the necessary police authority to enable him to kill, or order animals killed, to impose quarantine and prescribe conditions of quarantine in accordance with the law dealing with infectious diseases of animals and the rules of the state board of health. He shall have authority to use his judgment in releasing quarantine in unusual cases, independent of the rules governing quarantine.

The recommendation was adopted.

The request that the executive committee be authorized to employ such veterinary assistance as necessary during the hog cholera season of 1899 was granted.

Dr. Wesbrook's request that he be permitted to order supplies for the laboratory was approved and granted, the amount to be expended for such supplies not to exceed $700 for this order.

Authority was given the executive committee to act as an auditing committee to regulate the apportionment of the expenses of the board to the various funds.

Adjourned.

H. M. BRACKEN, M. D.,
Secretary and Executive Officer.

Oct. 10, 1899.

Dr. Staples not being able to be present, Dr. Hutchinson, vice president, presided.

Roll call: Present—Drs. Henry Hutchinson, Henrik Nissen, M. H. Reynolds, Chas. Lyman Greene, F. F. Wesbrook and H. M. Bracken.

The minutes of the previous meeting were read and approved.

Unfinished Business: With regard to inspection of schools, it was decided to try and reach this matter through medical men on school boards. Its further consideration was referred to the executive committee.

Methods of dealing with reported cerebro-spinal meningitis was referred again to the executive committee.

The proposed sheep scab circular was referred to the executive committee for further action.

Questions relating to water supplies and sewage disposal were again referred to the executive committee.

Questions relating to discharge of waste from creameries, slaughter houses, tanneries, factories, etc., were again referred to the executive committee.

The possibility of requiring a burial permit in all cases was again referred to the executive committee.

The question of encouraging breeders and dairymen to use the tuberculin test, by the issuance of clean bills of health by the state board to tested cattle, was referred to the director of the veterinary department, to report to executive committee.

New Business: Relating to employment of Dr. Annand. It was directed that his services be continued until December 1st, and longer if needed.

Relating to delegates to the meeting of the American Public Health Association at Minneapolis, October 31st to November 3rd, inclusive. It was moved by Dr. Greene that all members of the board serve as delegates to this meeting, and that their necessary expenses while in attendance be paid by the board, also membership fees, and that a special invitation be extended to Dr. Staples. Motion was seconded and carried.

Relating to rules to govern the disposal of garbage, the collection of ice, and the regulation of slaughter houses. These were referred to executive committee for further consideration.

Relating to card catalogue system for vital statistics. This system was, by motion, adopted, its use to begin with Jan. 1, 1900.

Relating to the printing of this quarter's report. By motion, seconded and carried, it was decided to print the same for distribution.

Adjourned.

H. M. BRACKEN, M. D.,
Secretary and Executive Officer.

Oct. 24, 1899.

The meeting was called to discuss the present epidemic of smallpox in and about Albert Lea.

Dr. Henry Hutchinson, vice president, was in the chair, Dr. Staples not being able to attend.

Roll call: Present—Drs. Henry Hutchinson, H. Nissen, C. L. Greene, M. H. Reynolds and H. M. Bracken.

The present condition of the smallpox epidemic in and about Albert Lea was explained by the secretary. As bearing upon this, the following letters were read:

Albert Lea, Minn., Oct. 23, 1899.

Dr. H. M. Bracken, Secretary State Board of Health, St. Paul, Minn.,

DEAR SIR: At request of the local board of health, I met with them today, and we talked over the situation at Albert Lea. I am surprised to learn that the state board of health are so exercised about smallpox here, and our citizens have not realized the condition. I am informed that you intend quarantining the entire city, and also that you have written to our neighboring cities warning them against Albert Lea. Is this correct or not?

I suppose you realize what a general quarantine means? It would work

a hardship to our business interests that would be irreparable, and practically ruin many of our merchants. I can simply say that the local board of health are now erecting a pesthouse, and will place in the house, under charge of a trained nurse, all patients that we can induce to go there—and they say that most of them will go willingly—and the local board intend to carry out the quarantine orders to the best of their ability. But a general quarantine must not be declared against us so long as the local board are acting in good faith.

The current talk on the street is to the effect that you are inclined to issue this order owing to some article that appeared in one of our local papers. In this regard will say that we are not responsible for any newspaper criticisms, and if you have any personal difference with any local paper, the city must not be made to suffer for it.

If you intend attempting a general quarantine against this city, I would consider it a personal favor if you so advise.

Yours truly,
(Signed) W. A. MORIN,
Mayor pro tem and President of Council.

Oct. 24, 1899.

W. A. Morin, Esq., Albert Lea, Minn.,

MY DEAR SIR: In reply to yours of October 23d:

It is strange that your citizens seem so slow in realizing that you not only have smallpox in your city, but that you are getting the ill-will of the country all around you by careless methods in dealing with it.

August 31st I received a letter from Dr. Blackmer, stating that there were two cases of what seemed to be chickenpox in Albert Lea. I replied at once as follows:

"Yours relating to possible cases of chickenpox received. I will urge you to keep these cases quarantined, even if diagnosticated as chickenpox. It is better to err on the safe side. We are having many cases throughout the state of mild smallpox at the beginning, which are later followed by fatal ones, and this is sufficient reason for being very cautious."

These letters relate to the Jenson boys, who had, as I feared, smallpox. My advice was not followed.

September 29th I visited Albert Lea, and unearthed *thirty cases* of mild smallpox in Albert Lea up to that date. I outlined advice at that time, which seemed satisfactory. Two weeks later I again went to Albert Lea, and found that my advice had not been followed. I expressed myself as dissatisfied with the methods pursued in dealing with the outbreak. After this second visit to Albert Lea, I did send out a circular letter to your neighboring health officials, giving a statement of facts and placing them on their guard.

After another week, my third visit was made to Albert Lea, and I felt compelled, in justice to the rest of the state, to take a very positive stand for the future. At that time (October 21st) there were eight centers from which to spread infection in Albert Lea. Some of these were carefully cared for; some of them were not observing quarantine as they ought. In some places there could not be anything but exposure, under the conditions, for some time. There is but one way to handle smallpox, and that is in quarantine hospitals properly cared for. There should be no more objection to a quarantine hospital than to any other hospital, if properly handled.

I appreciate the injury to commercial interests of a complete tie-up, by a general quarantine, but our duty is to the whole state. If Albert Lea has to be quarantined against, the citizens of Albert Lea will have no one to blame but themselves. Your methods have been abominably lax and reckless, and in strong contrast to those pursued in neighboring villages and cities to which you have spread smallpox. You are being damned by these places into which you have introduced smallpox, together with demoralization of business, and you deserve all the damning you are getting, too.

I named a condition by which your city might still avoid a general tie-up. Accept it, and conduct your quarantine as it should be from this tme on, and we will do all we can to help you out. Continue as you have been doing—i. e., doing as you pleased, regardless of people outside of Albert Lea—and the tie-up will speedily come. I know of sixty-three cases of smallpox traceable to Albert Lea infection, with more to follow. You say all patients that can be *induced to* will go to the quarantine hospital. I say, if you wish to avoid general quarantine, *all cases*, as specified by our board, and *all future cases*, will go to the quarantine hospital.

As to the current talk on your streets regarding myself, I care nothing. Neither do I care what your newspapers say about me. I am a state official, and as such will try to do my duty to the state. A special meeting of the state board of health has been in session to-day for the purpose of discussing Albert Lea methods, and a general quarantine will be advised against Albert Lea if the following smallpox patients are not removed from their homes to a properly equipped and cared-for quarantine hospital before 6 p. m. of Wednesday, October 25th:

The three children in the Wood's family, the four children last ill in Mr. Nic. Johnson's family, the child at Mr. Deveraux's, Miss Evenson, Dr. Potter's child, and any new cases that may have appeared since the above have been discovered.

At the time of my first visit to Albert Lea (September 29th) I was asked what I would do if Albert Lea did not do what the state board directed, and my reply was that we would do just what we now state we will do.

Respectfully,
(Signed) H. M. BRACKEN,
Secretary.

It was advised by the board that the letter to Mr. Morin be published, provided quarantine was not properly established at Albert Lea before Thursday, October 26th.

NOTE.—By a later motion of Dr. C. L. Greene (seconded by Dr. Nissen, and carried), the executive officer was empowered to extend the time before advising general quarantine against Albert Lea forty-eight hours, should it seem advisable.

Dr. Greene moved that the secretary's course in regard to the establishment of strict quarantine against Albert Lea be approved by the board, and that if general quarantine against Albert Lea becomes necessary, the reason for same be published; also, that

the secretary be instructed to continue action along the lines laid down in his letter to Mr. Morin, of this date. Seconded by Dr. Reynolds and carried.

The following rules for the regulation of the care and quarantine of smallpox were presented, and, by motion of Dr. Nissen, seconded by Dr. Reynolds, were adopted.

1. *Smallpox Physician.*—Wherever smallpox is present the local board of health must secure a competent physician to attend the patients as necessary, and to regulate the quarantine of the place where the patient is confined.

2. *Quarantine the Patient.*—The quarantine of smallpox is most important, for the danger of conveying the disease to others continues for some time after the apparent recovery of the patient; therefore, in no instance shall any smallpox patient be released from quarantine without the consent of the recognized quarantine physician.

3. *Time of Quarantine for Smallpox Patient.*—In no case shall a smallpox patient be released from quarantine in less than four weeks from the appearance of the disease. Quarantine can only be released at the end of four weeks, provided the recognized quarantine physician can report desquamation complete and the patient entirely free from the danger of conveying the disease to others. Cases that are not released at the end of four weeks should be examined from week to week, and finally released when the quarantine physician can report the desquamation complete and the patient entirely free from the danger of conveying the disease to others.

4. *The Release of a Smallpox Patient From Quarantine.*—When any smallpox patient is about to be released from quarantine after smallpox, there must be a thorough cleansing of the body by means of a disinfecting bath and a complete change of clothing.

5. *Release of Those Who Have Been Exposed to Smallpox.*—People who have been resident in any infected house where a smallpox patient has been must be thoroughly cleansed by means of the bath, and must make a complete change of clothing, and must then keep away from the quarantined house. Such individuals must be kept under close observation for a period of three weeks after the last exposure to smallpox—a period sufficient to cover the incubation of this disease.

6. *Release of House From Quarantine After the Removal or Recovery of a Smallpox Patient.*—The house and its contents must be disinfected by a competent disinfecter, according to the plan outlined in the Minnesota state board of health circular on smallpox.

7. *Exposed Individuals.*—All persons who have been exposed to smallpox must be vaccinated at once, and kept under observation for three weeks, or kept under quarantine for a period of three weeks.

8. *Relating to Attendance at Schools.*—In any school district where smallpox is near at hand, the non-vaccinated attendants—teacher or pupil—must be excluded from school until two weeks after a successful vaccination has been secured; otherwise the school must be closed.

9. *Suitable Dress for the Physician Attending Smallpox.*—Physicians who attend smallpox patients must wear a protective gown, with hood, which shall cover the *entire* person. Such gown may be made of unbleached mus-

lin, denim or other suitable material. It should have drawstrings in the sleeves at the wrists, and in the hood. The gown should be moistened when about to be worn with a one to one-thousand solution of corrosive sublimate, or a five per cent solution of carbolic acid. The face of the physician should be covered with a handkerchief or a strip of gauze, the hands should be covered with rubber gloves, and rubbers should be worn on the feet over the shoes.

Dr. Bracken requested the appointment of Dr. O. E. Roedli as special inspector for the Minnesota state board of health in Freeborn County during the present epidemic of smallpox. Request was granted by vote of the board.

The duties of Dr. Roedli were set forth in the following letter:

Oct. 23, 1899.

Dr. O. E. Roedli, Albert Lea, Minn.,

MY DEAR DOCTOR: With the present condition of smallpox in and about Albert Lea, it seems desirable that the state board of health should have some one as its special agent to look after this disease. You have to-day, at a special meeting of the state board, been made our special agent for Freeborn county during the present epidemic.

It is desirable that one man should familiarize himself with the care and quarantine of smallpox, and look after *all* cases in a given community. I am, therefore, going to instruct, for the state board of health, the various township officials in Freeborn county to work together, as provided for in section 14 of inclosed law. (Chap. 132, Laws of 1883.) At the same time, I am going to advise them to employ you as the physician to look after their smallpox cases, as provided for in the marked section (4) of inclosed law.

Regarding the rules we have just passed: Those relating to schools should be enforced through the county superintendents of schools or the school directors, I presume.

You will see from the copy of my letter to Dr. Blackmer what cases must be in quarantine hospital before 6 p. m. Wednesday, October 25th, if Albert Lea is to avoid general quarantine.

Mr. Hanson (the man with the broken leg) can be examined by you October 27th, and if no roughness is found, and you can pronounce him free from danger to others, he may then be disinfected and released from quarantine. If not safe in your estimation, quarantine should be continued until such time as you may see fit to release him.

Senator Knatvold's daughter can be examined October 27th by you, and dealt with under the same condition as prescribed for Mr. Hanson above.

Miss Lysne can be examined by you four weeks from the time that her case was reported to Dr. Blackmer, and the quarantine released or continued, as you shall advise.

The oldest Wood's boy can be examined by you October 28th, and quarantine released or continued, as you may advise.

Knutson (now in quarantine hospital) can be examined by you four weeks from the time that he went to the quarantine hospital, and quarantine released or continued, as you may advise.

All other cases now in quarantine, or that may hereafter be placed in

quarantine, must be kept in quarantine four weeks, as a minimum time, and then only released provided the skin is smooth, with desquamation entirely complete.

I am not going to assume that the state board of health should do the duties of the local boards. If Albert Lea wishes to employ you to look after the smallpox cases in the city, all right. From these instructions, however, you are only acting for the state board of health in order to protect the state at large from Albert Lea's recklessness. If Albert Lea authorities do not wish to recognize your right to regulate the release of quarantine, under supervision of the state board of health, the alternative will be quarantine against your city by the rest of the state and Iowa. In the country it will be necessary for you to regulate the quarantine and release of same for the following cases now existing:

James Olson's family, Albert Lea township; Thomas Olson's family, Albert Lea township; Berglund family, Albert Lea township; T. Gjellum's family, Albert Lea township; P. Kiel's family, Bancroft township; J. Counter's family, Alden township; case near Glenville and others that may occur.

Houses from which smallpox patients have been removed should be cleaned up thoroughly at once. This responsibility rests, in the city, upon the local authorities, and, in the country, upon the board of supervisors. Quarantine must not be removed from any house until there has been thorough disinfection. The inmates of a house where smallpox has existed must be kept under careful observation for three weeks from the date of last exposure.

You must satisfy yourself that the houses from which I have directed the smallpox patients to be removed to the quarantine hospital are thoroughly disinfected before quarantine is removed, viz., the houses of Dr. Porter, Evenson, Deveraux and N. Johnson.

I trust that you may be able to work smoothly with the local boards in this matter, and that they may see their way clear to employ you.

If there are any points upon which you are in doubt, please write me, and I will try to explain them.

Very truly,
(Signed) H. M. BRACKEN,
Secretary.

Dr. Bracken presented the following letter of instructions to health officers and acting health officers in Freeborn County:

MY DEAR SIR: At a special meeting of the Minnesota state board of health, October 24th, Dr. O. E. Roedli of Albert Lea was made special inspector of the board in Freeborn county, to act in the effort to control the further spread of smallpox. No case of smallpox shall be released from quarantine in Freeborn county without his permission, from this time on until further notice.

Smallpox is prevailing to a great extent in and about Albert Lea. It is very important that we should do our utmost to control the spread of the disease. The regulation of quarantine is quite as important for the good of the community as is the care of the sick. In regulating quarantine, the work can be more efficiently looked after by one physician than by many men. Taking into consideration the marked portions of sections 4 and 14 of the

law, I would advise and request that you employ Dr. O. E. Roedli of Albert Lea to care for and regulate the quarantine of all cases of smallpox within your jurisdiction.

It would be well for the various boards of supervisors to meet together at some common place, and talk this matter over. Advise with Dr. Nissen, who is a member of the state board of health, as to place and time of meeting.

Please note inclosed copy of the rules of the state board of health. It is your duty, directly or through Dr. Roedli, to see that they are enforced.

Very truly,
(Signed) H. M. BRACKEN,
Secretary.

By vote, the board recommended the issuance and sending out of such circular letter.

On motion of Dr. Greene, seconded by Dr. Nissen, the executive committee was empowered to take any action that may be demanded by reason of smallpox in this state, and furthermore, that the same authority may be considered as applying to all similar emergencies demanding immediate action, in order to avoid dangerous delay. Motion carried.

Adjourned.

H. M. BRACKEN, M. D.,
Secretary and Executive Officer.

Jan. 9, 1900.

The meeting was called to order at 10:40 a. m.

Roll call: Present—Drs. Staples, Hutchinson, Reynolds, Mayo, Stocker, Shumpik and Bracken.

Dr. Staples was elected chairman *pro tem.*

The minutes of the regular meeting of Oct. 10, 1899, and of the special meeting of Oct. 24, 1899, were read and approved.

Dr. Hutchinson moved that the board proceed to elect officers for the ensuing year. Dr. Shumpik seconded the motion, and it was carried.

Dr. Hutchinson spoke of the interest taken and good work done by Dr. Staples as member and president of the board, and nominated him as president. Dr. Mayo seconded the nomination. Dr. Shumpik moved that the vote be made by rising, which was done, and Dr. Staples was elected unanimously. Dr. Staples accepted the election, and expressed thanks to the board.

Dr. Mayo moved that Dr. Hutchinson be nominated as vice president. Dr. Stocker seconded the nomination, and it was unanimously carried by a rising vote.

The matter of electing the executive committee was discussed. Dr. Hutchinson moved that Dr. Reynolds be elected as a member of this committee. Dr. Shumpik seconded the motion, and it was carried unanimously.

Dr. Hutchinson moved that Mr. Mayo be elected as a member of this committee. Dr. Stocker seconded the motion, and it was carried unanimously.

Dr. Bracken spoke of the work of Dr. Wesbrook as director of the laboratory, and the standing the laboratory has attained through his efforts, and moved that the board extend to him a vote of thanks. Dr. Mayo seconded the motion, and it was carried by a unanimous rising vote.

Dr. Stocker moved that Dr. Wesbrook be elected as director of laboratory for ensuing year, and that present salary be continued until further action. Dr. Bracken seconded the motion, and it was carried.

The past policy of the board was outlined by Dr. Bracken, showing, among other things, that the object had been to secure the greatest amount of efficient service for the board with the money appropriated.

Certain points as bearing upon the future policy of the board were outlined by Dr. Bracken. Dr. Reynolds made supplemental remarks bearing upon this same question.

It was voted that Dr. Reynolds continue his work as director of the veterinary department for the present.

Dr. Hutchinson moved that the board hold an adjourned meeting, to be called by the secretary when found most advisable, and at the convenience of Governor Lind. Dr. Stocker seconded, and it was carried.

Dr. Hutchinson moved to adjourn. Seconded by Dr. Bracken and carried.

H. M. BRACKEN, M. D.,
Secretary and Executive Officer.

April 10, 1900.

The meeting was called to order at the offices of the board, in the Pioneer Press building, at 10:20 a. m., by the vice president, Dr. Hutchinson.

Roll call: Present—Drs. Hutchinson, Nissen, Reynolds, Stocker, Whetstone, Shumpik and Bracken.

The minutes of the last meeting were read and approved.

Unfinished Business: Dr. Stocker moved that the yearly periods for which the biennial reports are issued be made to coincide with the financial year. Motion seconded and carried.

Dr. Hutchinson, the vice president, being called away, appointed Dr. Reynolds to act as chairman.

Governor Lind arrived very soon after Dr. Hutchinson's departure.

Dr. Reynolds told what was being done by his department to prevent the spread of infectious diseases among animals.

The matter of examination of specimens involved in medical jurisprudence was brought up by Governor Lind and discussed. The governor thought the chemist employed by the board should make such examinations.

The governor also stated that he would like to see the different departments of the board concentrated and brought under one head as far as possible.

Shortly after Governor Lind's departure Dr. Stocker moved that the secretary be instructed to look into the feasibility of locating the offices of the board near the university campus.

Dr. Nissen moved, as an amendment, that a committee of three be appointed for this purpose. Seconded and carried.

Dr. Stocker moved that the executive committee constitute this committee. Dr. Whetstone seconded this motion, and it was carried.

Chemical Survey: Dr. Stocker moved that the matter of a chemical survey of a portion of the state during the summer be referred to the executive committee, with power to act, with a limit of expense for the same of $900. Dr. Bracken seconded the motion, and it was carried.

Dr. Bracken moved to adjourn to 2 o'clock. Dr. Stocker seconded the motion, and it was carried.

The meeting was again called to order by Dr. Reynolds at 2 o'clock p. m.

Dr. Stocker moved that the executive committee be given power to act in the matter of looking up a new site for offices in Minneapolis and the advisability of moving. Motion was seconded by Dr. Whetstone, and carried.

Suggestive Rules and Regulations: Dr. Stocker moved that the board instruct the secretary to send out an advisory letter em-

bodying the suggestions of the secretary regarding slaughter houses, and that the rest of the suggestions be left over till the next meeting. Dr. Shumpik seconded, and it was carried.

Baking Powders: Dr. Stocker moved that the board postpone consideration of the baking powder law indefinitely. Dr. Nissen seconded the motion, and it was carried.

Future Policy of the Board: Dr. Bracken stated that it was the governor's desire to have the work now carried on by the veterinary department at St. Anthony Park transferred to the secretary's office, to be under the direction of the secretary and executive officer.

Dr. Reynolds concurred in Dr. Bracken's statement, which he supplemented with the opinion that he would be compelled, for lack of time, to give up either his work in the university or for the board within a short time, and that he was prepared to turn over his work for the board as soon as desired.

Dr. Bracken moved that Dr. Reynolds' salary be continued until Aug. 1, 1900, and that he have charge of the work as at present until July 1, 1900. This was seconded by Drs. Nissen, Shumpik and Stocker, and carried.

Dr. Stocker moved that Dr. Reynolds be voted the thanks of the board, and that the board hereby express its appreciation of the work he has done as the director of the veterinary department in its organization. Motion seconded, and carried unanimously.

Salaries: The matter of employing Dr. L. B. Wilson in the laboratory for his whole time, and the increasing of his salary to $1,800 per annum, was discussed.

Dr. Whetstone moved that Dr. Wilson's services be continued as at present. Dr. Nissen seconded the motion, and it was carried.

Dr. Bracken moved that the sum of $350, or such portion thereof as necessary, be appropriated for the purchase of a microscope for the laboratory. Dr. Stocker seconded the motion, and it was carried.

Dr. Bracken moved that Dr. Wesbrook's request for two weeks' leave of absence be granted. Dr. Stocker seconded the motion, and it was carried.

Dr. Bracken moved that the matter of issuing a circular of information on sheep scab referred to the executive committee, with power to act. Dr. Stocker seconded the motion, and it was carried.

Board adjourned.

H. M. BRACKEN, M. D.,
Secretary and Executive Officer.

July 10, 1900.

The meeting was called to order by Dr. Hutchinson, the vice president, at 11:50 a. m., at the office of the board.

Roll call: Present—Drs. Hutchinson, Reynolds, Whetstone, Shumpik and Bracken.

The minutes of the last meeting were read and approved.

Relating to location of the office of the board, Dr. Shumpik moved that the secretary be empowered to lease the present rooms, and such additional rooms as found necessary, for one year. Seconded and carried.

The rules and regulations relating to school inspection in villages and cities, as recommended by the secretary and presented at the last meeting, were read.

The secretary also presented a recommendation relating to vaccination of school children.

Dr. Shumpik moved the adoption of the recommendations. Dr. Whetstone seconded the motion, and it was carried.

The rules and recommendations presented by the secretary relating to quarantine for scarlet fever, smallpox, measles, diphtheria, and the collection of ice were also adopted.

The secretary presented a table showing the prevalence of smallpox in the state since Jan. 1, 1899.

Dr. Shumpik moved that the state board of health indorse the action of the executive officer in requesting the local boards of health of San Francisco, St. Lawrence, Helena and Sand Creek townships to employ a competent person to make a house to house inspection for smallpox in their towns, and to see that proper quarantine was established and disinfection made before quarantine was raised; and further, that the executive officer of the state board of health be instructed to take similar action with other townships or local boards of health as necessity may arise.

Dr. Whetstone seconded the motion, and it was carried.

The board adjourned to 2 p. m.

The meeting was called to order again at 2:30 p. m.

Dr. Shumpik moved that any action on the question of the secretary's salary be idefinitely postponed. Dr. Reynolds seconded the motion.

Discussion.

With Dr. Reynolds' consent, Dr. Shumpik withdrew this motion, and moved that the chairman appoint a committee of three, of which the chairman be a member, to consider the matter of the

secretary drawing his salary from two sources, a report to be made by said committee at the next regular meeting of the board.

This was seconded and carried, and Dr. Hutchinson, the chairman, appointed to act with him Drs. Shumpik and Reynolds.

Relating to the request made by citizens of New Brighton, for inspection of stock at that place, Dr. Reynolds moved that it is not deemed expedient for the state board of health to maintain an inspection at the New Brighton stockyards, for the following reasons:

First—Because of the unwarranted expense.

Second—Because it would establish a bad precedent.

Third—Because it is unnecessary, for it is understood that the federal inspector at South St. Paul has instructions to give such inspection as is necessary at New Brighton.

The report of the director of the laboratory was presented, and read, in part, by Dr. Wesbrook.

The work of the St. Paul health department, in the matter of reporting to the state board, making second tests for tuberculosis and testing horses exposed to glanders, was discussed and criticised, but no action was taken.

Board adjourned.

H. M. BRACKEN, M. D.,
Secretary and Executive Officer.

Oct. 9, 1900.

The meeting was called to order by Dr. Henry Hutchinson, vice president, at 2:50 p. m., Oct. 9, 1900, it having been impossible to secure a quorum for a morning session.

Roll call: Present—Drs. Henry Hutchinson, M. H. Reynolds, Edward Shumpik, R. F. Whetstone and H. M. Bracken.

The minutes of the last meeting were read and approved.

Dr. Hutchinson, as chairman of the committee on the secretary's salary, then read the following report:

The committee appointed at the July meeting of the state board of health to consider the matter of salary of the secretary of the board, would respectfully submit the following for your consideration:

We find that the amount paid by the board alone is an insufficient salary for the large and constantly increasing duties of that office, and that the secretary of this board should receive not less than $3,500 per annum for his services. This is especially true, as the work and responsibilities of the office

have increased to such an extent as to compel the secretary to give up all private practice in his profession.

Since, however, our secretary is now drawing $2,500 as salary from the board and $1,000 from the university funds of the state as professor of materia medica in the medical department, which arrangement and compensation are satisfactory to him, and at the same time allows the state board of health $1,000 of its funds to be applied to other purposes, it is the opinion of your committee that it is to the best interests of the board that the present salary arrangement for this office be continued without change.

A motion was presented that the report be accepted as read. Motion was seconded and carried.

Dr. Bracken stated that two years ago he read a paper on "Leprosy in Minnesota" before the American Public Health Association, whereupon he was appointed chairman of a committee to consider the advisability of establishing national leprosaria. No report was made last year by this committee, because it was waiting to see what action the Marine Hospital Service would take. This year a full report will be made. Last year there were certain propositions acted upon by the Ramsey County Medical Society and the Minnesota Academy of Medicine, which read as follows:

To the Senators and Representatives of the United States Congress Assembly:

In consideration of the fact that leprosy exists to a limited extent in the United States; that the dangers of importaion of leprosy are on the increase; that the lepers themselves require more rational and humane treatment than is at present given them in this country; that the proper care of lepers by individual states is not practical; therefore, be it

Resolved, That the Ramsey County Medical Society of the State of Minnesota urge upon the United States government the necessity of establishing homes or colonies where lepers can be segregated, thus protecting the general public, and at the same time furnishing these sufferers a comfortable home and suitable medical care.

In our report this year to the American Public Health Association the following resolutions will be presented:

Whereas, It is a known fact that lepers are found in Canada, the United States and Mexico; that these lepers represent immigrants of many nationalities, together with some Americans; that the exclusion of leprous immigrants by inspection is impossible; that the tendency to importation of leprous immigrants in the future will be greater than even in the past; that the danger of infection of American residents abroad and the importation of the disease through these channels is greatly increased; therefore, be it

Resolved, That this association place itself on record as favorable to the establishment of national leprosaria, which may serve, not only as a refuge for lepers, but also as a home and hospital, making their lives tolerable so

far as possible, furnishing employment to those who are able to work, and giving skilled medical care to all cases, with the intent of possibly curing some, and making the road to death less wearisome and painful than it now is to others.

It would seem that this state should take a prominent part in this matter, for we have had a great deal of leprosy to look after. It would be well for this board to adopt either the resolutions adopted by these two societies or those which I have read, to be presented to the American Public Health Association at its next meeting.

Dr. Whetstone moved that the board adopt the resolutions just read.

Motion was seconded, and carried.

Dr. Bracken asked that the time for the biennial report be changed from the end of July, 1900, to as late a date as possible prior to Jan. 1, 1901.

Dr. Reynolds and Dr. Wesbrook said that they could have their reports ready at any time the board wished.

Dr. Bracken moved that the date for closing the present biennial report be changed from Aug. 1, 1900, to Jan. 1, 1901.

Dr. Reynolds seconded the motion. Carried.

Dr. Wesbrook then took up his report concerning the work in the bacteriological laboratory. He spoke particularly of the disease, hemorrhagic septicæmia, concerning which Drs. Wilson and Brimhall have presented a report to this meeting.

Dr. Bracken informed the board that he had authorized Drs. Brimhall and Wilson to buy necessary animals to carry on the experimental work in connection with this disease. So far $12 had been used.

Dr. Whetstone: Moved that the action of the secretary in authorizing this expenditure be indorsed. Motion seconded and carried.

Dr. Reynolds reported concerning his trip to Detroit, to attend the meeting of the Veterinary Medical Association. He promised Dr. Bracken that he would secure for the office three or four copies of the transactions of this meeting.

Dr. Bracken called on Dr. Brimhall for a statement of the clinical work in connection with the hemorrhagic septicæmia outbreaks reported upon. Dr. Brimhall read a summary concerning this work. He also told how fortunate the board was in having such a man to deal with as Mr. Arth, the owner of the cattle. Dr. Wesbrook again drew the attention of the board to the importance of this work.

Dr. Bracken read a report concerning the work for this quarter with tuberculosis, hog cholera, and glanders, after which Dr. Reynolds asked for information regarding the way in which Minneapolis and St. Paul had been reporting upon work relating to glanders and tuberculosis. He was given the desired information.

Dr. Reynolds asked for a financial report to be given each quarter by the secretary. The secretary then gave a report in a general way concerning present financial conditions, and said that he would give a full financial report at the next meeting.

Dr. Reynolds drew attention to the matter of pay per diem for the members of the board when in attendance at meetings of the board. After some discussion, the following resolution was adopted:

Whereas, In the past the members of this board have generously given their services without cost to the state, although this should not have been necessary, and has been an injustice to the members; therefore, be it

Resolved, That ten dollars per diem be paid each member when in attendance upon regular meetings or special meetings of the board, the same to take effect with the January meeting, 1901.

Dr. Bracken called the attention of the board to a little book which he presented, bearing the title "Disinfection and Disinfectants." This work was prepared for the embalmers. It was suggested that copies of this book be secured and presented to the medical health officers throughout the state.

The meeting then adjourned.

H. M. BRACKEN, M. D.,
Secretary and Executive Officer.

REPORT

OF THE

SECRETARY AND EXECUTIVE OFFICER.

CONDITION OF THE BOARD AND ITS WORK.

The board and its work are in excellent condition. The bacteriological laboratory, established four years ago, and placed on a more substantial footing by the action of the last legislature in granting it a special appropriation, has proven itself a most valuable adjunct. The work covered by the laboratory is that of (1) giving aid in the diagnosis of certain infectious diseases, (2) the clearing up of doubtful diagnoses, (3) the investigation of obscure diseases. In all of these points the work relates to infectious diseases of both men and animals.

While the laboratory is serviceable in dealing with diseases of men, it is especially so in dealing with diseases of animals, for in this field bacteriology and pathology are not in an advanced condition.

In thus speaking of the importance of the laboratory as related to research work bearing upon infectious diseases of animals, I have no wish to detract from the value of laboratory work in connection with the infectious diseases of man.

With a veterinarian as a member of our board, and at the same time holding a position in the teaching faculty of the experimental station at the Minnesota School of Agriculture. Also, with a capable field veterinarian who spends his spare time in the laboratory, it would seem that this board should be able to accomplish much for the stock interests of the state. That it has done so is amply borne out in that portion of this report which relates to the veterinary work.

The chemical work of the board is receiving such attention as our means will permit. Besides making analyses of samples of water sent us, a chemical survey of the state has been carried on during the last two summer seasons. Of this a detailed report will be given later on.

The board has adopted the card catalogue system for the filing of general data and for the returns of births and deaths. Returns of births and deaths are not made as promptly and completely as they should be, but this fault rests upon some of the local reporters. It is but right to state that not all who are engaged in this work are negligent. The authorities at Washington have promised us an opportunity to compare our records with those of the census

bureau. In this way we will be able to find out who are delinquent in making returns. The fund for carrying on the registration of vital statistics ($1,000) is entirely too small.

The work of the executive officer of the board is constantly increasing, and it is only because of the faithful and conscientious work of his clerks that he has been able during the past six months to perform his official duties without the aid of a medical assistant. It may be worthy of note that it has never been necessary to discharge a clerk from this office.

INFECTIOUS DISEASES OF MAN.

Diphtheria. The routine work of the laboratory in the examination for diphtheria is very helpful to the general practitioner throughout the state. With the aid of the laboratory it is quite possible to clear up doubtful diagnoses and to make plain the dangers existing. It was no uncommon thing prior to the establishment of the laboratory for mild epidemics of sore throat to exist for some time, not recognized as diphtheritic until death had claimed several victims. Now there is no excuse for such delay and dangers. It is a simple and inexpensive matter to have a culture sent to the laboratory in order to determine the presence or absence of the specific germ of diphtheria. If such is found, the duty of the local health officer is plain.

The quarantine of diphtheria can be carried on properly only when regulated by laboratory findings. A time limit is of no value in determining when a diphtheritic patient can be released from quarantine. This fact is so thoroughly recognized now that this board, at its July meeting, adopted the following quarantine regulations:

1. In all cases of suspicious sore throat a report must forthwith be made by the attending physician of such fact to the health officer. A culture must be taken at once by the health officer or attending physician, and sent to the laboratory of the state board of health for a bacteriological examination.

2. During the time between the sending of the specimen and the receipt of the report strict isolation of the patient must be maintained.

3. Whenever the presence of the *bacillus diphtheriae* is in any manner reported by a bacteriologist of the state board of health the house must forthwith be quarantined and a notice thereof posted in a conspicuous place thereon.

4. It shall be the duty of the attending physician to report to the local

health officer the names and addresses of those who have been exposed to diphtheria.

5. It shall be the duty of the local health officer to take and forward to the laboratory of the state board of health specimens from the throats of those reported to him to have been exposed to diphtheria, and pending a report thereon to see that isolation is maintained.

6. It shall furthermore be the duty of the health officer to place in quarantine those who, after exposure to cases of clinical diphtheria, are reported from the laboratory to be infected with *bacillus diphtheriae*, whether they show symptoms or not.

7. Quarantine shall be released in those houses in which diphtheria has been diagnosed when synchronous cultures taken from the noses and throats of all persons quarantined have been pronounced by a bacteriologist of the state board of health to be free of diphtheria bacilli.

8. Those living in a house in which diphtheria has been diagnosed, and who desire to escape quarantine, may do so on the receipt of a report from a bacteriologist of the state board of health, stating that cultures taken from their throats show the absence of diphtheria bacilli.

Between the taking of the specimen and the receipt of the report they must remain in isolation, and before leaving the house must take a complete bath and change all clothing. They must not return to the house until quarantine has been released.

9. After the laboratory diagnosis of diphtheria has been given, it shall be the duty of the health officer to see that specimens from both nose and throat of the patient are forwarded by himself or the attending physician at least once every week after clinical symptoms have subsided, until negative reports for both nose and throat are obtained.

10. Those who have been brought in contact with diphtheria patients and in whose throats diphtheria bacilli have been found shall be released from quarantine when both nose and throat cultures, on examination by a bacteriologist of the state board of health, no longer show the presence of diphtheria bacilli.

11. When the diphtheria bacillus exists for a period of more than three weeks after the disappearance of all throat symptoms, the bacillus will be isolated in pure culture and its virulence tested upon guinea pigs, at the request of the health officer. If the bacillus is not found virulent, quarantine may be released. As these experiments will take from five to ten days, later specimens ought to be sent to the laboratory, since they may show the absence of all diphtheria bacilli before complete determination.

12. All cultures sent to the laboratory are to be reported upon, in writing, by a bacteriologist of the state board of health, upon the morning following their receipt; provided, however, that such report will be made by telegram upon request, at the expense of the person making the request.

In country districts, where it is not possible to use the laboratory findings as a means of regulating quarantine, those suffering from diphtheria or associated with a diphtheria patient shall be quarantined for a period of not less than four weeks.

The value of our laboratory's research work in relation to diphtheria cannot be estimated. Papers have been presented upon this

topic at various state and national association meetings by Dr. F. F. Wesbrook, director of the laboratory, and by his assistants, and this state has reason to be proud of its position in the front rank as relating to recent knowledge acquired pertaining to this disease.*

It would seem that, with the facilities for an early diagnosis of diphtheria, together with the curative and prophylactic action of the antitoxic serum, we should be able to greatly reduce the ravages of this disease; and this expectation is an actuality, for the death rate from diphtheria has been constantly declining during the preceding five years, as shown by the following table:

DEATHS FROM DIPHTHERIA IN MINNESOTA.

1895	502
1896	473
1897	268
1898	238
1899	223

This constant decline in the number of deaths from diphtheria is more marked than would at first appear to the casual observer, for our population has been constantly increasing during the period referred to.

The decline is not as great as it should be, however. There are too many cases in which the physician is not called early enough, or where he fails to recognize the gravity of the disease when called. The statistics for the first nine months of 1900 are not what they should be. During this period 368 deaths were recorded from diphtheria, as shown by the table on pages 36 to 46.

The total deaths due to diphtheria in 1900 will far exceed those of 1899. This should not be so. There is still too much carelessness in dealing with the disease; too much temporizing with suspicious sore throats; too much indifference shown in the methods of quarantine; too much negligence in the prophylactic use of antitoxine.

A short time ago a circular letter was sent by me to 124 physicians in various parts of the state, asking for their opinions as to the value of antitoxine, and also for statistics bearing upon diph-

*These papers will appear in connection with the report from the Laboratory (see Index).

theria. Seventy-four replies were received. Of these, forty-four were from physicians in private practice, reporting a total of 645 cases of diphtheria within the last three years, with fifty-six deaths. Of these fifty-six fatal cases, thirty-nine had antitoxine prior to death, but seventeen of them were beyond help when the antitoxine was given. Judging from the histories of these thirty-nine cases, nearly all, if not all, might have been saved had the antitoxine been used early and in sufficiently large doses. The general concensus of opinion was in favor of this comparatively new remedy.

A few words relative to the dose of antitoxine may be of value. Often when a physician is called to a case of diphtheria, well advanced or of the laryngeal type, the dose of antitoxine given is entirely too small. With the patient thoroughly under the influence of the disease the treatment must be truly heroic if any good is to be accomplished. In seeking information relative to the maximum safe dose of this agent, I wrote to one who has charge of diphtheria connected with the city hospital service of a great city. The reply is of so much interest that I quote from it as follows:

> The first full hospital year of the ——— was from Feb. 1, 1896, to Feb. 1, 1897, during which year the death rate was 15.39 per cent. Since that time each succeeding year has seen a lessened mortality, and for the year 1899 it was 10.7 per cent. The medical care of the patients has not varied from the first, and this steady decrease can be accounted for only by the fact that antitoxine has been given more freely in *some* cases. I do not think that an overdose of antitoxine can be given; that is to say, I do not think harm to a patient would result from any amount of antitoxine. * * * Our practice at the hospital is to give antitoxine until the characteristic effect is produced on the diphtheritic membrane. * * * A striking feature of the diphtheria wards where antitoxine is properly used is the freedom from diphtheritic odor and the fact that but few of the entire number of patients seem sick. A very large per cent of our fatal cases die within the first twenty-four hours in the hospital—those moribund at entrance.

A recent writer states* that "no case of laryngeal diphtheria should receive less than 1,500 units, and children over two years should have 2,000 (the first dose), and an additional 1,000 units may be repeated every twelve hours, according to symptoms."

An initial dose of 1,000 to 4,000 units may be looked upon as quite reasonable, inasmuch as 60,000 units have been given to a

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*B. R. Shurly: Journal of the American Medical Association, May 19, 1900, p. 1231.

single case of laryngeal diphtheria from the beginning of the disease until recovery has taken place.

I do not consider the morbidity reports upon this disease as at all complete for the state, for many officials neglect to report *all* cases within their jurisdiction, while in addition many epidemics of a mild type of the disease are not reported at all.

Scarlet Fever. This disease has prevailed to quite an extent during the past two years—often of mild type and unrecognized.

The quarantine regulations for scarlet fever, as recommended by this board, are as follows:

"The time for the quarantine of scarlet fever shall not be less than four weeks from the first appearance of the disease. Quarantine shall be released thereafter only on condition that the process of desquamation is complete, as certified to by a reliable physician, the local health officer or his medical inspector."

The mortality in the state from scarlet fever during the preceding five years has been as follows:

1895	118
1896	63
1897	44
1898	45
1899	51

During the first nine months of 1900 (January to October) there have been forty-eight deaths from this disease, as shown by the table on pages 36 to 46.

It seems strange that there should still be confusion over the terms scarlatina, scarlet fever and scarlet rash, but such is the fact; not only by the laity, but also by some members of the medical profession. Not long ago I was called by a local health officer to determine the presence or absence of scarlet fever. At the station I was met by one of the older physicians, who assured me the uneasiness was entirely uncalled for; that the prevailing disease was nothing but scarlet rash. Quarantine had been broken by one family because of this dispute in diagnosis, and its members had gone to Sleepy Eye to visit. In due time marked cases of scarlet fever appeared in the visited family at Sleepy Eye. Again, complaint came to me from a layman regarding an epidemic disease prevailing in a certain village. Although there were physicians in

the place there was no local board of health. I therefore wrote to the president of the village council for information. He promptly replied, assuring me that there was no scarlet fever in the place, —nothing but scarlatina. It is not strange that epidemic diseases continue to prevail when such errors are made. The morbidity reports that we have relating to this disease for the past two years are of little value, for few health officials report all of the cases which occur within their jurisdiction, while many of the mild cases pass without a proper diagnosis having been made.

CASES AND DEATHS FROM DIPHTHERIA (INCLUDING CROUP) AND SCARLET FEVER

From January 1 to November 1, 1900.

	Diphtheria and Croup.		Scarlet Fever.	
	Cases.	Deaths	Cases.	Deaths
AITKIN CO.				
Lakeside tp	2	2	......	......
ANOKA CO.				
Anoka c	5	3	......	.....
Anoka tp	1	1	......	......
Burns tp	13	6	......	......
Centreville tp	2	......	......	......
BECKER CO.				
Frazee v	1	1	3	1
Richwood tp	6	2	......	......
BELTRAMI CO.				
Bemidji v	11	3	......	......
Copley tp	3	......	......	......
Eckels tp	2	2	......	......
Solway v	13	2	......	......
Unknown tp	4	......	......	......
BENTON CO.				
Alberta tp	1	1	......	......
Glendorado tp	5	......	......	......
Graham tp	......	......	4	......
Maywood tp	6	1	......	......
Minden tp	3	1	......	......

DEATHS FROM DIPHTHERIA AND SCARLET FEVER.—*Continued.*

	Diphtheria and Croup.		Scarlet Fever.	
	Cases.	Deaths	Cases.	Deaths
BIG STONE CO.				
Beardsley v	1	.....	.....	.....
Browns Valley tp	4	1	.....	.....
Graceville v	7	.....	.....	.....
Odessa v	3	.....	.....	.....
Otrey tp	2	2	.....	.....
BLUE EARTH CO.				
Garden City tp	2	1	.....	.....
Madison Lake v	.....	.....	2	.....
Mankato c	15	.....	20	.....
South Bend tp	6	.....	.....	.....
Vernon Centre tp	.....	.....	1	.....
BROWN CO.				
Bashaw tp	1	1	.....	.....
Lake Hanska tp	1	.....	.....	.....
Linden tp	.....	.....	1	.....
New Ulm c	1	.....	1	.....
Sleepy Eye v	1	.....	6	.....
CARVER CO.				
Camden tp	.....	.....	3	.....
Chaska tp	.....	.....	1	.....
Hancock tp	2	1	.....	.....
Hollywood tp	7	.....	1	.....
Waconia tp	1	1	.....	.....
Watertown v	2	.....	.....	.....
Young America tp	7	.....	.....	.....
CHIPPEWA CO.				
Clara City v	5	.....	.....	.....
Montevideo v	1	1	.....	.....
CHISAGO CO.				
Franconia tp	.....	.....	7	.....
Fish Lake tp	1	1	.....	.....
Nessel tp	3	.....	.....	.....
North Branch v	1	.....	.....	.....
Rush City v	18	.....	.....	.....
CLAY CO.				
Georgetown tp	.....	.....	1	.....
Hawley tp	1	.....	7	1
Hawley v	1	.....	2	.....
Kurtz tp	1	.....	.....	.....
Moorhead c	29	2	.....	.....
Morken tp	1	.....	.....	.....
COTTONWOOD CO.				
Mountain Lake v	1	.....	.....	.....
Windom v	1	1	.....	.....

DEATHS FROM DIPHTHERIA AND SCARLET FEVER.—*Continued.*

	Diphtheria and Croup.		Scarlet Fever.	
	Cases.	Deaths	Cases.	Deaths
CROW WING CO.				
Brainerd c	......	......	1	......
DAKOTA CO.				
Eagan tp	1	1	......	......
Eureka tp	1	......	......	......
Farmington v	1	......	2	......
Hastings c	10	......	......	......
Inver Grove tp	......	......	1	1
Lakeville tp	1	......	......	......
Lakeville v	2	......	......	......
Rosemount v	2	......	......	......
South St. Paul c	1	1	......	......
West St. Paul c	4	......	2	......
DODGE CO.				
Dodge Centre v	1	......	......	......
Hayfield v	......	......	7	......
Ripley tp	......	......	1	1
West Concord v	......	......	1	......
DOUGLAS CO.				
Hudson tp	4	......	......	......
Orange tp	......	......	1	1
Osakis v	1	......	1	......
Osakis tp	1	1	......	......
FARIBAULT CO.				
Blue Earth c	13	1	......	......
Delavan tp	1	......	......	......
Seely tp	1	......	......	......
FILLMORE CO.				
Bloomfield tp	1	1	......	......
Fillmore tp	1	......	......	......
Jordan tp	1	1	8	......
Norway tp	......	......	2	......
Rushford c	......	......	2	......
Wykoff v	1	......	1	......
York tp	......	......	1	......
FREEBORN CO.				
Albert Lea c	14	1	5	......
Alden v	21	2	......	......
Bancroft tp	3	2	......	......
Hayward tp	7	2	1	......
Manchester tp	1	1	1	......
Mansfield tp	3	......	......	......
Oakland tp	1	......	......	......
Shell Rock tp	5	......	......	......
GOODHUE CO.				
Kenyon v	5	......	......	......
Red Wing c	2	2	4	1

DEATHS FROM DIPHTHERIA AND SCARLET FEVER.—*Continued.*

	Diphtheria and Croup.		Scarlet Fever.	
	Cases.	Deaths	Cases.	Deaths
GRANT CO.				
Ashby v	......	......	1	......
Erdahl tp	......	......	1	......
Gorton tp	......	......	1	1
HENNEPIN CO.				
Bloomington tp	1	......	1	1
Champlin tp	2	1	......	......
Excelsior tp	1	1	......	......
Eden Prairie tp	......	......	1	......
Edina v	3	2	......	......
Minneapolis c	515	71	428	11
Maple Grove tp	4	3	......	......
Minnestrista tp	......	......	1	1
Plymouth tp	2	1	......	......
Wayzata v	2	......	......	......
West Minneapolis v	5	......	......	......
HOUSTON CO.				
Black Hammer tp	......	......	5	2
Caledonia tp	4	......	......	......
Caledonia v	26	1	......	......
Hokah v	......	......	2	......
La Crescent tp	2	......	......	......
Mayville tp	1	1	......	......
Sheldon tp	1	......	......	......
Spring Grove tp	......	......	2	......
Spring Grove v	1	......	......	......
Yucatan tp	1	......	......	......
HUBBARD CO.				
Farris v	......	......	1	......
ISANTI CO.				
Cambridge v	1	1	......	......
Cambridge tp	1	1	......	......
Dalbo tp	6	......	......	......
North Branch tp	5	......	......	......
Wyanett tp	25	9	......	......
ITASCA CO.				
Deer River v	5	1	......	......
Grand Rapids tp	3	2	......	......
Grand Rapids v	21	1	3	......
JACKSON CO.				
Alpha tp	......	......	1	......
Lakefield v	13	3	......	......

DEATHS FROM DIPHTHERIA AND SCARLET FEVER.—*Continued.*

	Diphtheria and Croup.		Scarlet Fever.	
	Cases.	Deaths	Cases.	Deaths
KANABEC CO.				
Comfort tp	3	......	......	......
Knife Lake tp	1	......	......	......
Mora v	1	......	1	......
KANDIYOHI CO.				
Green Lake tp	1	1	......	......
St. John tp	2	1	......	......
Willmar v	1	......	2	......
KITTSON CO.				
Hallock v	8	6	......	......
Hallock tp	1	......	......	......
Kennedy tp	2	......	......	......
Teien tp	6	1	......	......
LAC QUI PARLE CO.				
Madison v	......	......	1	......
LAKE CO.				
Two Harbors v	......	......	7	2
LE SUEUR CO.				
Le Sueur c	24	1	......	.....
Lexington tp	......	......	4	.....
Montgomery v	17	1	......	......
New Prague c	2	......	......	......
McLEOD CO.				
Bergen tp	2	2	......	.....
Brownton v	2	......	......	......
Hale tp	5	......	......	......
Rich Valley tp	29	2	......	......
Round Grove tp	3	......	......	......
Silver Lake v	1	......	......	......
Winsted tp	2	1	......	.....
MARSHALL CO.				
Argyle v	2	......	......	......
Cedar tp	1	1	......	.....
Middle River tp	1	1	......	......
Oak Park tp	1	1	......	......
Stephen v	1	1	......	......
Thief Lake tp	7	1	......	......
Warren v	3	......	......	......
MARTIN CO.				
Elm Creek tp	1	1	......	......
Fairmont v	......	......	2	......
Galena tp	......	......	1	1
Lake Fremont tp	1	1	......	......
Tenhassen tp	1	1	......	......
Waverly v	1	......	......	......
Westford tp	4	3	......	......

DEATHS FROM DIPHTHERIA AND SCARLET FEVER.—*Continued.*

	Diphtheria and Croup.		Scarlet Fever.	
	Cases.	Deaths	Cases.	Deaths
MEEKER CO.				
Forest Prairie tp	2	1	1	......
Kingston tp	6	......	......	......
Lester Prairie v	4	1	......	......
Manannah tp	1	1	......	......
Swede Grove tp	1	1	......	......
MILLE LACS CO.				
Bergholm tp	......	......	1	1
Bock tp	......	......	1	......
Greenbush tp	2	......	2	......
Milaca v	1	......	......	......
Milo tp	1	......	7	......
Princeton v	9	2	......	......
Tp. 43, R. 25	12	8	......	......
MORRISON CO.				
Bellevue tp	2	......	......	......
Cushing tp	1	1	......	......
Elm Dale tp	7	1	......	......
Little Falls c	1	1	......	......
Scandia Valley tp	......	......	1	1
Swan River tp	5	2	......	......
Two Rivers tp	1	......	......	......
MOWER CO.				
Adams v	1	......	......	......
Austin c	1	......	1	......
Dexter v	2	......	......	......
Le Roy v	1	......	......	......
Rose Creek tp	1	1	......	......
Udolpho tp	2	2	......	......
MURRAY CO.				
Des Moines River tp	1	1	......	......
Elsboro tp	1	1	......	......
NICOLLET CO.				
Belgrade tp	......	......	1	......
St. Peter c	4	......	......	......
NOBLES CO.				
Elk tp	1	1	......	......
Graham Lake tp	1	1	......	......
Kinbrae v	5	1	......	......
Worthington v	......	......	2	......
NORMAN CO.				
Fossum tp	3	......	......	......
Halstad v	......	......	1	......
Hendrum tp	......	......	1	1
Twin Valley v	1	......	......	......

DEATHS FROM DIPHTHERIA AND SCARLET FEVER.—*Continued.*

	Diphtheria and Croup.		Scarlet Fever.	
	Cases.	Deaths	Cases.	Deaths
OLMSTED CO.				
Dover tp	......	......	4	......
Haverhill tp	......	......	1	......
Kalmar tp	......	......	1	......
Rochester c	12	1	......	......
Stewartsville v	1	1	.....	......
OTTER TAIL CO.				
Aastad tp	1	1	......	......
Battle Lake v	.....	......	2	......
Deer Creek tp	......	......	1	......
Girrard tp	......	......	1	......
Henning tp	1	1	......	......
Leaf Lake tp	......	......	6	4
Maine tp	......	......	1	1
Newton tp	......	......	6	4
New York Mills v	......	......	1	......
Norwegian Grove tp	9	......	......	......
PINE CO.				
Dell Grove tp	9	3	......	......
Hinckley v	1	......	......	......
Sturgeon Lake tp	1	1	......	......
PIPESTONE CO.				
Altona tp	......	......	1	......
Fountain Prairie tp	......	......	1	......
Pipestone v	12	......	1	......
POLK CO.				
Crookston c	30	12	......	......
Emardville tp	1	.....	......	......
Fertile v	5	......	......	......
Fosston v	5	......	......	......
Gentilly tp	3	2	......	......
Gordon tp	3	......	......	......
Hubbard tp	......	......	1	1
Huntsville tp	3	1	......	......
Knute tp	......	......	1	1
McIntosh v	......	......	1	......
Nesbit tp	1	1	......	......
Liberty tp	1	1	......	......
Onstad tp	6	4	......	......
Winger tp	3	1	......	......
POPE CO.				
Walden tp	1	......	......	......
RAMSEY CO.				
New Brighton v	2	1	......	......
North St. Paul v	2	......	......	......
Rose tp	......	......	1	......
St. Paul c	294	36	227	7
White Bear tp	......	......	1	......

DEATHS FROM DIPHTHERIA AND SCARLET FEVER.—*Continued.*

	Diphtheria and Croup.		Scarlet Fever.	
	Cases.	Deaths	Cases.	Deaths
RED LAKE CO.				
Lake Pleasant tp	1	1	......	......
Red Lake Falls v	4	2	......	......
Red Lake tp	1	1	......	......
River Falls tp	2	1	......	......
Rocksbury tp	2	2	......	......
Thief River Falls v	1	1	......	......
REDWOOD CO.				
Granite Rock tp	......	......	2	2
Lamberton v	......	......	5	1
Lamberton tp	......	......	2	......
Paxton tp	......	......	1	1
Vesta tp	......	......	1	......
RENVILLE CO.				
Emmett tp	2	1	......	......
Hawk Creek tp	1	1	......	......
Olivia v	8	1	......	......
Renville v	4	......	......	......
Sacred Heart tp	1	......	......	......
Wang tp	2	1	......	......
RICE CO.				
Cannon City tp	......	.....	1	......
Faribault c	2	......	8	......
Northfield c	5	......	......	......
Richland tp	1	1	......	......
Wolcott tp	1	1	......	.....
ROCK CO.				
Clinton tp	1	1	......	......
Luverne v	37	1	......	......
ROSEAU CO.				
Barto tp	1	......	......	......
Ross tp	9	3	......	......
ST. LOUIS CO.				
Duluth c	73	4	55	......
Biwabik v	1	......	......	......
Breitung tp	......	......	1	......
Eveleth v	9	......	......	......
Floodwood v	......	......	1	......
Herman tp	1	1	......	......
Hibbing v	......	......	1	1
Mesaba tp	2	1	......	......
Tower c	6	1	1	......
Virginia c	2	......	......	......

DEATHS FROM DIPHTHERIA AND SCARLET FEVER.—*Continued.*

	Diphtheria and Croup.		Scarlet Fever.	
	Cases.	Deaths	Cases.	Deaths
SCOTT CO.				
Blakely tp	1	......	......	......
Credit River tp	1	1	......	......
Cedar Lake tp	1	......	......	......
New Market tp	1	......	......	......
SHERBURNE CO.				
Elk River v	7	......	......	......
SIBLEY CO.				
Bismarck tp	2	2	......	......
Henderson tp	1	1	......	......
STEARNS CO.				
Avon tp	5	2	......	......
Avon v	1	1	......	......
Brockway tp	1	1	......	......
Cold Spring v	1	......	......	......
Crow Lake tp	1	1	......	......
Eden Lake tp	2	2	......	......
Holding v	1	......	......	......
Holding tp	1	1	......	......
Kimball v	......	......	2	......
Lynden tp	1	1	......	......
New Paynesville v	11	2	......	......
Oak tp	3	......	......	......
Paynesville v	4	3	......	......
Rockville tp	1	......	......	......
St. Cloud c	28	2	4	......
St. Joseph v	3	3	......	......
Sauk Centre c	2	......	1	......
Wakefield tp	1	1	1	1
STEELE CO.				
Blooming Prairie tp	1	1	......	......
Summit tp	1	......	......	......
STEVENS CO.				
Hodges tp	1	1	......	......
Morris v	2	1	......	......
SWIFT CO.				
Hayes tp	1	1	......	.....
Shible tp	1	1	......	......
Torning tp	1	......	......	......
TODD CO.				
Bertha tp	......	......	1	......
Bertha v	......	......	7	......
Burleine tp	......	......	1	1
Claressa v	......	......	5	......
Grey Eagle v	3	......	......	......

DEATHS FROM DIPHTHERIA AND SCARLET FEVER.—*Continued.*

	Diphtheria and Croup.		Scarlet Fever.	
	Cases.	Deaths	Cases.	Deaths
TODD CO.—*Cont.*				
Long Prairie v	3	1	......	......
Hartford tp	1	1	......	......
Leslie tp	2	1	......	......
Ward tp	1	1	......	......
TRAVERSE CO.				
Lake Valley tp	2	1	......	......
Wheaton v	2	......	......	......
Windsor tp	5	......	......	......
WABASHA CO.				
Highland tp	1	1	......	......
Lake City c	1	......	......	......
Wabasha c.	1	......	......	......
Watopa tp	......	......	1	......
WADENA CO.				
Lyons tp	2	......	......	......
Verndale v	1	1	2	1
Wadena v	1	......	22	2
Wadena tp	......	......	1	1
WASECA CO.				
Alton tp	......	......	1	......
Iosco tp	2	2	......	......
Janesville v	......	......	1	......
St. Mary tp	1	......	......	......
Waseca c	1	......	......	......
WASHINGTON CO.				
Alton tp	......	......	1	......
Baytown tp	1	1	2	......
Forest Lake v	2	......	......	......
Stillwater c	2	1	3	3
Stillwater tp	......	....	3	......
WATONWAN CO.				
Adrian tp	6	2	......	......
Butterfield v	5	1	......	......
Butterfield tp	7	......	......	......
Madelia v	2	......	......	......
Nelson tp	1	1	......	......
St. James tp	......	......	3	1
St. James v	10	......	3	......
WILKIN CO.				
Deerborn tp	6	......	......	......
Breckenridge v	1	......	......	......
Brandrup tp	1	1	......	......
Prairie View tp	3	......	......	......

DEATHS FROM DIPHTHERIA AND SCARLET FEVER.—*Continued.*

	Diphtheria and Croup.		Scarlet Fever.	
	Cases.	Deaths	Cases.	Deaths
WINONA CO.				
Dresbach v	......	......	2	......
Elba tp	4	2	......	......
Elba v	2	......	......	......
Rollingstone v	1	1	......	....
Utica tp	1	1	......	......
Warren tp	1	......	......	......
Winona c	17	8	31	1
WRIGHT CO.				
Buffalo v	3	2	......	......
Clearwater v	3	1	.....	.....
Cokato v	1	1	......	......
Cokato tp	1	1	......	......
Maple Lake v	......	......	7	......
Otsego tp.	1	......	......	......
St. Michaels v	1	1	......	......
Stockholm tp	2	1	......	......
Woodland tp	2	1	.....	......
YELLOW MEDICINE CO.				
Canby v	3	......	......	......
Granite Falls c	3	......	......	......
Lisbon tp	2	2	......	......
Swede Prairie tp	1	1	......	......
Totals	1,986	368	1,032	62

The following table shows the various means of securing data relative to diphtheria and scarlet fever. From this and the preceding table one can easily see that all cases of infectious diseases are *not* reported by the various loca health officers:

	Outbreaks First Reported by Health Officer.	Outbreaks First Learned of Through Returns of Deaths.	Outbreaks First Learned of Through Laboratory.	Outbreaks First Learned of Through Newspapers.	Total Outbreaks Reported.	Total Cases Known of by State Board of Health.	Total Deaths Known of by State Board of Health.
Diphtheria (including Croup)	157	81	51	45	334	1,986	368
Scarlet Fever	82	15	......	19	116	1,032	62

Measles. This disease shows quite a high mortality. During the preceding five years deaths have occurred as follows:

1895	73
1896	137
1897	28
1898	254
1899	44

During the first nine months of 1900 there have been sixty-three deaths from measles.

It may be well to call attention to a statement made in our last biennial report (p. 270), to the effect that "every case of measles should be looked after from the outset by a physician. Daily professional visits may not be necessary, but the laity should understand that measles is a disease not free from danger, and that the responsibility connected with it should rest upon a physician rather than upon the guardians or parents of the patient. Proper advice from a physician at the outset of the disease may prevent the appearance of dangerous complications or sequelæ; neglect of such advice may be followed by the death of the patient." All patients suffering with measles should be kept in quarantine for a period of not less than two weeks from the onset of the disease.

You will see by comparing the death rate from measles during the years 1895-99, inclusive, with that of scarlet fever that it has been the more fatal of the two, for the respective deaths have been 596 (measles) and 363 (scarlet fever).

Smallpox. This disease has given a great deal of trouble since January, 1899. While epidemic, it has generally been of mild type, and the diagnosis has often been disputed by the laity and certain physicians, they claiming that a disease of such mild type could not be smallpox. It is hard to reason with such people. They cannot be made to understand that a diagnosis of smallpox may be made without the assistance of death.

It is often said that smallpox came to us from the Philippine Islands. This is not true. There is but one of the cases reported for this state from Jan. 1, 1899, to Nov. 1, 1900, that is traceable to this source. It is possible that the disease involving other persons might be due to infection from this party, but all attempts to establish such a source of infection have failed.

The history of this epidemic may be interesting:

In May a gentleman returned from California to his home near Worthington. On his way home he spent a short time in Nebraska. At the time, or soon after he reached home, he had an eruption, which was called chicken-pox. He was in no way quarantined, but was about the streets of Worthington as though not ill in any way. Shortly after his return home his wife was taken ill with smallpox and died. The physician who attended her also contracted the disease and died. There were eight cases in all in this group, six of whom recovered.

In January, 1899, a sleeping-car porter from the Pacific coast introduced smallpox into St. Paul. Resulting from this exposure were thirty-one cases, with one death.

May 23d a call was made upon this board to examine conditions existing at Appleton, Minn. Dr. A. W. Miller, who had had quite an experience with the smallpox in St. Paul, was sent to Appleton. He pronounced the disease smallpox. Later I visited this place, and found that in all there had been eleven cases of smallpox, without a death. The infection was traceable to Merriam Park, and thus to the sleeping-car porter who brought the disease from the Pacific Coast to St. Paul. The attending physician at Appleton who had failed to make a diagnosis of smallpox gave his mistakes quite an amount of notoriety through the press, lay and medical, trying to explain away the true diagnosis.

It would seem that smallpox gradually worked its way from the Pacific Coast to Minnesota. In September, 1899, a physician, writing from Great Fall, Mont., stated that a disease strongly resembling smallpox was prevailing at that place at that time, He said that if it was smallpox, it was general throughout all of northern Montana. It was but a short time after this that several deaths occurred from this disease in Montana, and the doubting Thomases who needed such evidence were then able to clear up their diagnoses. Prior to this date two cases of smallpox came to this state from Great Falls, Mont., one to St. Cloud and one to Willmar. In both cases the disease was promptly recognized as smallpox, quarantined and exterminated.

In the spring and early summer of 1899 there was smallpox in North Dakota, presumably on its march from the Pacific Coast by way of Montana. June 30, 1899, I visited East Grand Forks and found several cases of smallpox, recovered or existing. There was smallpox in Grand Forks at this time, not recognized prior to my visit. After the disease was recognized as smallpox it was properly quarantined and brought under control. There was one

death at Grand Forks. About the last of June a young attorney from Grand Forks visited his mother in Albert Lea. While there he had what was called chicken-pox. In August the health officer wrote to me, reporting two young men, who were running a cash grocery store, as ill with chicken-pox. I wrote to him to be on his guard, stating that this was in all probability smallpox, and advising him to quarantine the young men. Hearing nothing further from him, I supposed the cases had been properly handled. On September 27th I was called by telegram to Albert Lea. I there found several active cases of smallpox, with a total record of about thirty cases up to that date, all traceable to infection from the young man from Grand Forks, and among these cases were the two young men who had been reported to me as ill with chicken-pox. In fact, the disease had remained in one locality until these young men distributed it to their customers. Smallpox continued in and about Albert Lea for some time, giving a total of 101 cases recorded, with no deaths in that place, but four deaths at other places to which the infection had been carried from Albert Lea. When the attention of the local authorities was drawn to the fact that smallpox was with them, it seemed to have little effect. The most primitive methods of quarantine were adopted where anything at all was done, and it was only after a change of health officers was made and a great amount of financial loss had been thrust upon the city that such steps were taken as to bring the epidemic to a close.

In October, 1899, a young woman from Carver county visited a sister who was a servant at the B— Hotel, in Minneapolis. At the time she was just recovering from a rash which she stated was due to chicken-pox. She also stated that the whole family had had the same disease. Later developments proved this in all probability to have been smallpox. Where it came from I have not been able to determine by correspondence, nor have I had time to visit the place myself in order to trace its origin, if possible. After the return of this young woman to her home, her sister (the servant) went home, and also had what was called chicken-pox. A few days later another servant in this same hotel was found to be ill with an eruptive disease which was diagnosed as smallpox by Dr. Norred, and was sent to the Minneapolis pesthouse November 1st.

A clerk in one of the leading dry goods houses had a meal ticket at the B—Hotel, where the girl who was sent to the pesthouse November 1st was a waitress. In due time this young man had a rash which was not diagnosed. Others in the same store had this same disease, and as the Thirteenth Regiment returned from the Phil-

ippines about this time, it was given the name of "Philippino Itch." From these parties there was quite an infection which was later recognized as smallpox, and the poetry of Philippino infection was removed, for it came from no more distant place than the B— Hotel through the waitress. A man living at 15 W— Ave., and boarding at the B— Hotel had what was called chicken-pox. He passed the disease from one to another at his place of rooming until finally one infected young man went to Janesville, Minn., where he had smallpox. Inquiry there elicited the fact that a case had been recognized as smallpox in this house on W—. avenue by the husband of the patient first. A physician confirmed this diagnosis, and reported the fact to the health office. The commissioner of health is said to have visited this place, and to have pronounced the disease nothing but chicken-pox. Smallpox under the name of chicken-pox made various excursions from 15 W— avenue. Among the places visited were Wahpeton, N. D., and Hoff township, Pope county, Minn. In this latter place there was one death from hemorrhagic smallpox. Although several diagnoses of smallpox had been made by competent physicians in Minneapolis, to be marked and called chicken-pox by the then commissioner of health, it was not until January 23, 1900, that the city was forced to recognize the presence of smallpox. The local health authorities still refused to call it smallpox, and continued to aid in its dissemination. The local authority not being willing to take active steps looking to the suppression of the disease, finally had his control over eruptive diseases taken from him, and given to a special inspector, who, with a moral but no legal obligation from the city to pay him for his services, sometime, fought the disease, and the local health authorities, practically alone for five months, when public opinion came forward to his support, with sympathy, but still no cash. This man, who deserves much credit for the thankless task he undertook, was Dr. C. H. Norred.

Smallpox was introduced into Duluth from Minneapolis and again from Texas.

The following table gives a record of all cases of smallpox reported to the state board of health from January, 1899, the beginning of the present outbreak in this state, up to Nov. 1, 1900, the time for closing this biennial report. The source of infection, so far as known, is also given for each outbreak. From this it is readily seen that the returning soldiers are in no way responsible for our smallpox, and that Minneapolis is responsible for a very large percentage of the cases occurring in the state after Nov. 1, 1899.

RECORD OF SMALLPOX IN MINNESOTA

From Jan. 1, 1899, to Nov. 8, 1900.

	1899.		1900. (To Nov. 8th.)		Infection.
	Cases.	Deaths	Cases.	Deaths	
ANOKA CO.					
Anoka c	......	......	47	......	Mpls. and Verndale.
Anoka tp	......	......	15	......	Minneapolis.
Bethel tp	......	......	5	......	"
Ham Lake tp	......	......	8	......	"
BELTRAMI CO.					
Popple tp	......	......	6	......	?
CARLTON CO.					
Atkinson v	......	......	4	......	Duluth.
Carlton v	......	......	2	......	"
Twin Lakes tp	......	......	2	......	Stony Brook.
CARVER CO.					
Benton tp	......	......	4	......	Minneapolis.
Chaska c	......	......	6	......	"
San Francisco tp	......	......	2	......	"
Hollywood tp	......	......	1	......	?
CASS CO.					
Township 134	......	......	21	......	?
CHIPPEWA CO.					
Louriston tp	......	......	5	......	?
COTTONWOOD CO.					
Westbrook tp	......	......	1	......	Minneapolis.
CROW WING CO.					
Brainerd c	1	......	1	......	? and Akely.
Ripley tp	......	......	14	......	Little Falls.
DAKOTA CO.					
Inver Grove tp	8	......	......	......	?
DODGE CO.					
Ellington tp	......	......	2	......	Minneapolis.
West Concord v	......	......	1	......	?
FARIBAULT CO.					
Delavan tp	......	......	1	......	Winnebago.
Foster tp	......	......	1	......	Albert Lea.
Wells v	1	......	......	......	"
Winnebago v	......	......	3	......	St. Charles.
FREEBORN CO.					
Albert Lea c	81	......	20	......	Grand Forks.
Albert Lea tp	6	......	2	......	Albert Lea.
Alden tp	3	......	......	......	"

NOTE.—"c" indicates city; "v" village; "tp" township. The * is used before the names of those places where smallpox was still present Nov. 8, 1900.

RECORD OF SMALLPOX IN MINNESOTA.—*Continued.*

	1899.		1900. (To Nov. 8th.)		Infection.
	Cases.	Deaths	Cases.	Deaths	
FREEBORN CO.—*Cont.*					
Bancroft tp	2	......	......	......	Albert Lea.
Carlston tp	1	......	......	......	"
Freeman tp	1	......	1	......	"
Hartland tp	......	......	1	......	"
Hayward tp	11	......	2	......	"
Mansfield tp	1	......	......	......	"
Moscow tp	1	1	......	......	"
Nunda tp	7	......	21	......	"
Shell Rock tp	1	......	......	......	"
GOODHUE CO.					
Cherry Grove tp	......	......	4	......	Minneapolis.
Red Wing c	......	......	1	......	Denver, Col.
Warsaw tp	......	......	2	......	Minneapolis.
Vasa tp	......	......	4	1	"
HENNEPIN CO.					
Brooklyn tp	.....	......	3	......	Minneapolis.
*Champlin tp	......	......	16	1	Mpls. and Michigan.
Dayton tp	......	......	5	......	Minneapolis.
Medina tp	......	......	5	......	"
Minneapolis c	9	......	......	......	St. Paul.
*Minneapolis c	23	.....	416	13	Carver Co.
HOUSTON CO.					
Black Hammer tp	......	......	1	......	Atkinson.
Sheldon tp	......	......	5	......	Montana.
HUBBARD CO.					
Akely v	......	......	32	......	Atkinson
ITASCA CO.					
*Grand Rapids v	......	......	1	......	Montana
KANDIYOHI CO.					
*Atwater v	......	......	5	......	?
Gennessce tp	......	......	5	......	Minneapolis.
*Harrison tp	......	......	1	......	Atwater.
Lake Elizabeth tp	......	.....	5	......	Minneapolis.
*Whitefield tp	......	......	1	......	Willmar.
Willmar v	1	......	......	......	Great Falls, Mont.
*Willmar v	......	......	1	. ....	Threshing crew.
Willmar tp	.....	......	6	......	Minneapolis.
LAC QUI PARLE CO.					
Lake Shore tp	1	......	......	......	Appleton.
LAKE CO.					
Two Harbors v	......	......	9	......	R. R. and lumber camps.
Two Harbors tp	......	......	4	......	" "

RECORD OF SMALLPOX IN MINNESOTA.—*Continued.*

	1899.		1900. (To Nov. 8th.)		Infection.
	Cases.	Deaths	Cases.	Deaths	
LE SUEUR CO.					
Derrynane tp	......	......	1	......	Minneapolis.
" "	......	......	9	......	Belle Plaine tp.
*Cleveland tp	......	......	10	......	Sharon tp.
*Cordova tp	......	......	3	......	Le Sueur.
*Le Sueur	......	......	3	......	?
*Sharon tp	......	......	2	......	Minneapolis.
LINCOLN CO.					
*Tyler v	......	......	1	......	Minneapolis.
"	......	......	1	.....	Marshall.
McLEOD CO.					
Winsted v	.....	......	18	......	Minneapolis.
MARTIN CO.					
Cedar tp	......	......	3	......	Minneapolis.
Fairmont v	9	3	......	......	Albert Lea.
Westford tp	......	......	2	......	Otter Tail Co.
MEEKER CO.					
Dassel v	......	......	1	......	Atkinson.
Dassel tp	......	......	3	1	"
Ellsworth tp	......	......	2	......	?
*Litchfield v	......	......	3	......	Minneapolis and ?.
MILLE LACS CO.					
Princeton v	......	......	1	......	Nickerson.
MORRISON CO.					
Little Falls c	......	......	54	1	Minneapolis.
MOWER CO.					
Austin c	6	......	......	......	?
NICOLLET CO.					
*New Sweden tp	......	......	3	......	?
*St. Peter c	......	......	2	......	Winnebago and New Sweden tp.
NOBLES CO.					
Round Lake v	12	4	......	......	?
Worthington v	8	2	......	......	Nebraska.
" "	......	......	1	......	Iowa.
OLMSTED CO.					
Rochester c	1	......	......	......	?
OTTER TAIL CO.					
Dead Lake tp	......	......	15	......	Rush Lake tp.
Fergus Falls c	......	......	2	......	?
Girard tp	......	......	4	2	Inman tp.

RECORD OF SMALLPOX IN MINNESOTA.—*Continued.*

	1899.		1900. (To Nov. 8th.)		Infection.
	Cases.	Deaths	Cases.	Deaths	
OTTER TAIL CO.—*Cont.*					
Henning v	......	.....	1	......	?
Inman tp	......	......	2	......	?
Rush Lake tp	......	......	9	......	Hibbing.
PINE CO.					
Nickerson	......	......	7	......	Duluth.
PIPESTONE CO.					
Jasper v	......	......	8	......	Minneapolis.
POLK CO.					
East Grand Forks v	14	......	1	......	Grand Forks.
POPE CO.					
Hoff tp	......	......	8	1	Minneapolis
RAMSEY CO.					
St. Paul c	22	1	......	......	Great Northern R. R.
*St. Paul c	......	......	43	1	Minneapolis, etc.
White Bear tp	......	......	1	......	Minneapolis.
RENVILLE CO.					
Bandon tp	......	......	1	......	Minneapolis.
RICE CO.					
Bridgewater tp	......	......	13	......	?
Faribault c	7	.....	......	......	Iowa.
Morristown tp	......	......	1	......	Minneapolis.
Northfield c	......	......	39	......	"
Webster tp	......	......	12	......	"
ST. LOUIS CO.					
Breitung tp	......	......	2	......	?
Clinton tp	.....	......	1	......	Lumber camp.
Duluth c	1	......	......	......	South St. Paul.
*Duluth c	......	......	85	......	Texas.
Stuntz tp	......	......	1	......	Lumber camps.
SCOTT CO.					
Belle Plaine tp	......	......	6	......	Minneapolis.
Blakely tp	......	......	3	......	"
Helena tp	......	......	19	......	"
Jackson tp	......	......	4	......	"
Jordan tp	......	......	81	......	"
St. Lawrence tp	......	......	2	......	"
Sand Creek tp	......	......	28	......	"
Shakopee c	......	......	5	......	"
Spring Lake tp	......	......	1	......	"

RECORD OF SMALLPOX IN MINNESOTA.—*Continued.*

	1899.		1900. (To Nov. 8th.)		Infection.
	Cases.	Deaths	Cases.	Deaths	
SHERBURNE CO.					
Baldwin tp	......	......	7	......	Nickerson.
Livania	......	......	1	......	Baldwin tp.
STEARNS CO.					
Albany tp	4	......	......	......	?
*St Cloud c	3	......	......	......	Montana.
STEELE CO.					
Havana tp	......	......	3	......	Minneapolis.
Owatonna c	......	......	4	......	"
SWIFT CO.					
Appleton v	11	......	......	......	St. Paul.
TRAVERSE CO.					
Arthur tp	......	......	5	......	Wells tp.
Browns Valley v	......	......	1	......	Arthur tp.
Wells tp	......	......	14	......	Dead Lake tp.
WABASHA CO.					
Kellogg v	......	......	11	......	?
Wabasha c	......	......	8	......	St. Paul
WADENA CO.					
Leaf River tp	......	......	2	1	Winnipeg.
Wing River tp	......	......	11	......	"
WASECA CO.					
Janesville v	......	......	1	......	Minneapolis.
New Richland v	......	......	1	......	Albert Lea.
WATONWAN CO.					
Butterfield v	......	......	14	......	Minneapolis.
Butterfield tp	......	......	3	......	"
Long Lake tp	......	......	4	......	"
Odin tp	......	......	1	......	"
Rosendale tp	......	......	2	......	"
St. James v	......	......	20	......	"
WILKIN CO.					
McCauleyville tp	......	......	3	......	Minneapolis.
WINONA CO.					
St. Charles v	......	......	3	......	Winona and St. Charles tp.
St. Charles tp	......	......	4	......	Winona.
Utica v	......	......	2	......	"
Winona c	......	......	6	......	

RECORD OF SMALLPOX IN MINNESOTA.—*Continued.*

	1899.		1900. (To Nov. 8th.)		Infection.
	Cases.	Deaths	Cases.	Deaths	
WRIGHT CO.					
*Franklin tp	.....	......	8	......	? and Willmar.
Marysville tp	......	......	10	......	Atkinson.
Middleville tp	......	......	9	......	"
Waverly v	......	......	4	......	"
Total	257	11	1,371	22	

Grand Total, 1,628 cases—33 deaths.

Counties infected, 53.

Localities infected, 145.

The disease exists at present (Nov. 8, 1900) in 11 counties and 19 localities.

It has been due to Minneapolis infection in 53 localities in 23 counties, with 543 cases and 5 deaths. Including the cases in Minneapolis itself, this gives a total of 959 cases and 18 deaths due to Minneapolis infection.

The following, abstracted from "personal" observations of Dr. Haggard, one of the smallpox inspectors under Dr. Norred, may be of interest:

"This study is based upon the observation of 163 cases of smallpox which occurred in Minneapolis between the dates of March 6 and June 20, 1900. Of these cases eighty-seven were males and seventy-six females. The ages ranged from two months to seventy-ty-four years, as follows:

Under two years	17 cases.
From two to five years	25 cases.
From five to ten years	30 cases.
From ten to fifteen years	23 cases.
From fifteen to twenty years	17 cases.
From twenty to thirty years	18 cases.
From thirty to forty years	18 cases.
From forty to sixty years	14 cases.
Seventy-four years	1 case.
Total	163 cases.

"For convenience these cases are divided into seven groups according to severity, as follows:

1. Smallpox, *without eruption*	4
2. Very mild smallpox	28
3. Mild smallpox	42
4. Mildly severe smallpox	49
5. Severe smallpox	23
6. Confluent smallpox	11
7. Malignant smallpox	6
Total	163

"Of the first group I have personal knowledge of the cases having had all the prodromal symptoms and signs of smallpox except the eruption, the symptoms occurring at the proper period after exposure to smallpox in persons associated with patients having a well developed eruptive form of the disease. There were other cases in Minneapolis during this period belonging to this group reported to me by others, consequently not introduced in this list. These 163 cases were from fifty-seven different houses.

"The infectiousness of the disease and the protection of vaccination was well shown. Two individuals while sitting near a person in the eruptive stage of the disease in a physician's waiting-room were infected, and in due time had the disease. A policeman who was keeping guard in a quarantined house, and who is said not to have had anything to do with the patients nor to have entered the house, presumably carried the disease to his home, over two miles distant, to those who could not have been exposed in any other way.

"In the fifty-seven infected houses were 126 with constant exposure who did not contract the disease, presumably because of protection from previous vaccination. Those exposed and not having been vaccinated and those in whom repeated vaccinations failed to act, although not protected by a previous vaccination, were almost always victims to smallpox.

"Of these 163 smallpox patients 126 had not been vaccinated; twenty-seven had been vaccinated, but ten of these vaccinations were more than ten years old; ten were vaccinated after exposure to smallpox, and in these the vaccinia and smallpox were both present at the same time, while ten were not questioned as to vaccination. These facts speak forcibly for compulsory vaccination and correct quarantine methods. Of the early symptoms, fever, the one most constantly present, may be overlooked entirely in children, or recognized only as fretfulness. It may also happen in the mild cases that the fever will accompany, but not precede,

the eruption in children. In the severer forms of the disease fever is almost always, if not always, present. If the case is malignant, the temperature, contrary to some writers, may be subnormal for days at a time, especially after the eruption has appeared. In some severe cases the temperature fall may be momentary only, the fever being practically continuous throughout the course of the disease.

"Chills are very inconstant. They may be the first prodromal symptom; they may be alternating in close succession. They have been absent or unrecognized in a large proportion of the cases under consideration.

"Pain in the lumbar region is quite constant as an early symptom in the severe cases, and is fairly constant in the medium grades of the disease. In the mild cases headache is a prominent early symptom. Associated with the early headache may be general pains. The first pains may be in the feet and legs. There are sometimes fleeting pains appearing in the head, the back, the legs and then in the abdomen. In the severe cases the pain in the back continues after the eruption appears. Sore throat is a common symptom in all the types of smallpox described. It may be the earliest symptom; it may appear with the eruption or even later, then disappear promptly, or develop into a most annoying condition. There may be only a diffused redness, or the eruption may cover the entire pharyngeal surface. The throat has sometimes an apparently diphtheritic gangrenous slough on the tonsils, severe adenitis, with pain and dysphagia. There may be aphonia, or the hoarse whisper of 'croup' and choking that alarms the attendants. The breathing, for days, may be like that of a severe diphtheria, in which the nose is stopped and the fauces closed at the end of each inspiration and expiration. The peculiar odor which is said to attend smallpox is noted only in the cases of some severity. It is of such a character and appears so early in the disease as to be of material benefit in making a diagnosis. This early odor is unlike that which comes later, the odor of suppuration.

"In some cases there is severe sweating at about the fifth to the seventh day of the disease, and this is accompanied by a great stench irrespective of the extent of the eruption.

"The tongue, quite constantly, has a fine, white coating, with the shape and palor so common in atonic diseases. In the severe cases it often has the appearance of the so-called typhoid fever tongue. In the milder cases the tongue may have no vesicles upon it, or only a few, as in chicken-pox; but in the severe cases it may

be thickly covered with the eruption. Loss of appetite is a common early symptom, and may be somewhat prolonged in the severe cases. Nausea or vomiting, or both, are common early symptoms, and these two may continue to be present for some time in the severe cases.

"Weakness is often extreme when the duration of illness is taken into account. Diarrhoea is a somewhat common symptom in all forms of the disease, but is most marked in the severer forms. Constipation required some attention in twenty per cent of the cases.

"Sleeplessness has been present in half the cases, lasting but a few days in the mild type, but quite persistent in those more seriously ill. In these latter the use of the milder hypnotics seemed to have but little effect.

"Convulsions occurred in three children in the early stages of the disease. Delirium occurred in twenty-seven cases, and was most frequent in the early or febrile period. Tremor of the hands is a common symptom, occurring after the fifth day, slight in the mild, but in an aggravated form in the severe cases.

"With so many grades of severity, and with the varying reaction of the skin, a great range in the degree of the eruption is not strange. This creates much confusion and discomfiture in the minds of physicians who have had little experience with the disease. It is not uncommon to find a diagnosis of grippe, typhoid fever, measles, scarlet fever, or even erysipelas, made before the correct diagnosis is reached. In several cases of purpuric variola the disease has been classed as purpura hemorrhagica, or 'black measles,' or 'heart failure,' or 'gastric catarrh.'

"Some writers state that it is impossible to distinguish purpura variola from purpura hemorrhagica without a knowledge of association and infection with smallpox. This has proven true in this epidemic.

"It is necessary to be guarded in making a negative diagnosis when smallpox is prevailing in mild form. The patient and his friends are generally certain that the mild cases cannot be smallpox. The patient is said to have been 'working too hard,' or to have 'cooled off too soon,' or to have 'ridden too far on a wheel,' or to have 'had such attacks before.' He is subject to 'lumbago,' The eruption is 'due to the heat,' to 'medicine taken,' or to 'bad blood.' If the physician sees the patient but once he is apt to make a diagnosis of grippe, rheumatism, typhoid fever, or a cold. If he makes later visits he is very likely to find an eruption that does

not belong to any of these diseases, and which as certainly is not chicken-pox.

"One must not adhere too closely to the classical description of smallpox eruption, for he may be misled. In the mild cases there may be only a few broad and flat papules, not acuminate, of irregular outline and uneven size. These reach the stage of involution so early that the case is out of quarantine in half the usual time. For example: A child aged five years was vaccinated a few days after exposure to his father, who was ill with smallpox. Thirteen days after such exposure there were marked prodromal symptoms of smallpox. Later four papules appeared upon the child's neck, and these increased in prominence for two days, then decreased for a like period of time, and disappeared without vesiculation. Vaccinia was actively present at the same time with these mild symptoms of smallpox.

"In other cases, after the severe prodromal symptoms, an eruption, thickset and hemorrhagic, may appear. There may be marked prostration and delirium. By the fourth or fifth day of the eruption all symptoms may change for the better, evidently under the impress of an old vaccination, and the patient's case progress as a typical varioloid.

"There were other cases resembling this last group in their general characteristics, but without previous vaccination, and hence mild in character independently of any influence from vaccination. There were still other cases with a mixed eruption. Thus M. and E., sister and brother, aged respectively eleven years and ten months, were ill. The histories of these two cases were practically the same. There was fretfulness, fever, malaise, sore throat, headache on the third day, a macular eruption of irregular size, and most marked on the head, hands and feet. From the center of many of these maculae developed, within twelve to twenty hours, a small dome-shaped, transparent vesicle, with thin top, which would break within the next twenty hours, leaving the usual flat, dry, dark scab, of irregular size, so characteristic of chicken-pox. But accompanying these typical prodromal symptoms of smallpox, with the rash of chicken-pox, was another eruption of papules going on to vesiculation slowly, as in smallpox, full and tense at the end of a week; mostly round, but occasionally oval; refilling quickly when emptied. These had thick tops and a hyperplastic base. There was an elevated ring left when the usual smallpox scale dropped off.

"In these 163 cases of smallpox the following complications

were met with in one or more cases: Brachial paresis preceded by a neuritis; severe inflammation of the eyes, lasting from seven to ten days; suppurative otitis media; impetigo following the desquamation; facial erysipelas following the secondary fever (in one case); burrowing abscesses over back, sacrum and buttocks. There were small wounds of the skin, which showed no disposition to heal so long as the eruption was active. In one case the nails dropped off, and this was in process when death occurred in another case. In one case there were bed sores. Many of the severe cases had a crop of pimples following the desquamation. Inflammation of the glands of the neck, of the groin or of the axillae was noted in ten per cent of the cases. Accompanying this was chills, irregular temperature, and local pain. There was a marked variation in the size of these glandular and periglandular swellings, which advanced and receded from day to day. The skin was not so brawny over these glands as is usual in such inflammations. The softness and mobility of the glands was striking. Upon the rapid recession in size of the glands, without rupture, the skin would lay in folds where it had previously been tense. The disorders of the alimentary canal were mostly following the secondary fever, and were represented by gastroduodenitis, accompanied by jaundice or by gastro-enleritis.

"Four of the patients were pregnant women. One of these aborted at the third month, with severe hemorrhage, the smallpox being at the height of the eruptive stage. The other three pregnant women recovered from smallpox without accident."

My views upon this mild type of smallpox were forced into print in reply to a paper under the title of "Psuedo or Modified Smallpox—Which Is It?" read at the Atlantic City meeting of the American Medical Association, June 7, 1900, by Dr. T. J. Happel of Trenton, Tenn. They are represented in the following paper:

PSEUDO, MODIFIED. OR TRUE SMALLPOX—WHICH IS IT?*

The first term is in common use at the present time. Let us analyze it. It is applied indiscriminately to a mild eruptive disease prevailing quite generally throughout the southern and middle states and, to a limited extent in other parts of the country. This disease is admittedly like smallpox in many of its characteristics, but those who use the above term in describing it insist that certain characteristics of smallpox are absent. I presume no one will dispute the fact that the disease prevailing so generally, whether accompanied by slight or severe symptoms, is one and the same when the line of infection is clearly continuous. It is therefore all smallpox or not

*From the Journal of the American Medical Association, Sept. 8, 1900.

smallpox. Let us consider carefully some of the arguments used against the diagnosis of this epidemic disease as true smallpox.

First, the mildness of the disease! It is absurd in this day of advanced knowledge to put forward such an argument. We all know that there may be mild epidemics of diphtheria, in which the majority of cases may show but little membrane; that often diphtheria prevails as an epidemic under the false name of tonsillitis until a few deaths arouse the lethargic physician, or a microscopic examination reveals the presence of the bacillus of diphtheria. Who would say that an epidemic sore throat with the specific bacillus of diphtheria present was not diphtheria because the disease was of a mild type, and had none of the dangerous symptoms of malignant diphtheria? Again, we have probably all seen an epidemic disease with many of the characteristics of scarlet fever but varying in degrees of intensity from the mildest rash, characterized by the old-woman doctors of both sexes as scarlet rash, to the severest type with the accompanying fatal sequelae. Would any intelligent physician of modern days say that the cases with the mild symptoms and those of the severe type were not one and the same? It was not many years since it was considered necessary to have the typical history of typhoid fever before we were willing to call a fever by this name, but now we know that there may be a mild typhoid fever with very few of the classic symptoms of that disease. Let us be reasonable, then, and admit that while it is the rule to have a mortality of from 25 to 50 per cent. with smallpox, it may be possible to have the disease in a mild form with a very low mortality.

The eruption is said not to conform to the book description of smallpox. Are we such slaves to books that we can not make a diagnosis of smallpox without all the cases having an ideally-formed eruption? It is no uncommon thing to find grouped together cases with the typical eruption at one extreme and the non-eruptive cases at the other, with all grades of eruptions between. Would any one with the history of a common infection say that some of these cases were smallpox and the others not? What would those who need a classical eruption in order to make a diagnosis do with the most fatal of all, the hemorrhagic cases? I presume they would call them purpura hemorrhagica instead of hemorrhagic smallpox.

The temperature is said to to be too mild in the majority of cases. Why should not the temperature be mild if the infection is mild? It certainly would be a freak of nature to cause a prevailing fever out of all proportion to the degree of infection. The secondary fever is said to be absent. The physician who has to wait for the secondary fever of smallpox before he can make a diagnosis would do well to change his profession. Why should there be marked secondary fever when the eruption is mild? Not long ago I saw a young lady with probably not more than a dozen smallpox pustules on the entire body. Why should she have secondary fever? Her brother, a young man, contracted the disease from her. He had confluent smallpox and a secondary fever.

Those who wish to call this mild type of smallpox by some other name point to the fact that good authors state the danger of infection from smallpox is present during the entire progress of the disease, and that in this epidemic all who are exposed to a given case at a given time do not promptly succumb at one and the same date, about fourteen days from the time of ex-

posure. But why should they? All individuals may not be equally exposed at one time. Some may be more susceptible to infection than others. It is possible for an individual to have absolute resistance to infection at one time and not at another. It is even possible to have a natural immunity against this disease, the same as with other infectious diseases. Some writers at least who use the evidence of mild or irregular infection as an argument against smallpox, in speaking of this disease recognize the fact, nevertheless, that as a rule it attacks all, or at least many, of the non-immune members of a household when it once appears. Those physicians who consider the disease smallpox are cognizant of the fact that all who are subjected to a casual exposure do not of necessity become ill. Why should they? With the disease in mild form it is quite natural that the degree of infection should be mild. But even with the disease in severe form a casual exposure is not necessarily followed by infection. About one year ago I visited a child who died of confluent smallpox while I was at the house. Her father, a physician, had failed to recognize the disease. As a consequence the whole village had practically been exposed, many of the inhabitants more than once, for the child lay ill in a semi-public room and had many visitors. Yet, following this there were only eight cases from direct infection.

It is said that some of the prodromal symptoms of true smallpox are wanting in this epidemic. Granting this to be so, it proves nothing. We do not need all of the classical symptoms of typhoid fever in order to make a diagnosis. If a few typical ones are present, that is sufficient. I venture to say that with the exception of the smallpox cases without eruption, all of those occurring even in mild form have a sufficient number of symptoms at some stage of the disease to enable the careful observer to recognize the presence of smallpox.

Some of the doubters state that vaccination does not protect against the prevailing epidemic. This does not agree with my experience. An old vaccination, an imperfect vaccination, a vaccination made after exposure, may not afford protecton. But in a large percentage of *successful*, recent vaccinations protection is complete. Some have been vaccinating these cases during or immediately following their recovery with the belief that evidence of a successful vaccination under such conditions would tend to stamp the disease as not smallpox. Such a test is absolutely useless. There is no reason why vaccinia and variola should not exist at one and the same time in an individual. They may have some influence on each other without complete antagonism. It would be strange, however, if all those who had this mild form of smallpox should respond to vaccination made a sufficiently long time after recovery from the first disease. I do not think they all will, and my opinion in this matter has been borne out by the experience of those observers with whom I have been associated.

Regarding the advisability of calling this mild type of smallpox—for such it undoubtedly is—a modified smallpox there is little to say. It certainly is not varioloid, for by this we mean smallpox modified by vaccination, and many of these mild cases under consideration have never been vaccinated. If vaccination had been practiced quite generally over our entire country thirty and forty years ago, and then neglected during the past twenty years, we might then think that a partial immunity had been secured. I do not lean to this latter belief, but rather to the opinion that we

have nothing more or less than a mild type of disease, such as may occur at times with other infectious diseases. A few illustrations may be of value.

About a year ago I was called to see a man, aged forty years, suffering from an eruptive disease called chicken-pox by his attending physician. He gave the history of having had somewhat marked symptoms before the eruption appeared, with but little discomfort afterward. The case had not been quarantined before the seventh or eighth day of the disease. The population of the village was about 1,100. Investigation brought out the fact that in all there were eleven cases in this village; nine preceding and one following this man. Most of these were adults, all closely associated. None had as marked eruption as the man under consideration. All had marked prodromal symptoms, but not all of those described in books as belonging to smallpox. The source of infection for these cases was traceable to undoubted smallpox. The man under consideration had smallpox. The others had beyond doubt the same disease, although in very mild form. None of the cases were fatal.

Again, in the early spring of 1899, a man, aged probably fifty years, returned from California, visiting for a time in Nebraska before reaching his home in southern Minnesota. At the time of reaching home he had a mild eruption, which did not discommode him at all, and which he called chicken pox. Shortly after his return, his wife became ill with smallpox and died. She undoubtedly contracted the disease from her husband, who had had smallpox in mild form instead of chicken-pox. There were six other cases of smallpox from these exposures, varying in degree from a very mild exanthem to a most marked eruption. One of the patients, a physician, died of smallpox contracted while attending the first fatal case.

Again, early in August of 1899, it was reported to me that two young men, doing business in a city having a population of about 3,000 inhabitants, were ill with chicken-pox. I advised the local health officer to be on his guard, as in all probability the young men had smallpox in mild form. Later I learned that no heed had been given my advice. The young men had carried on their business as grocers, regardless of the disease. From this infection there were in this city and vicinity over two hundred cases of smallpox *without a death.* However, there were four deaths in places somewhat remote, traceable to infection at this place.

It is not difficult to furnish illustrations like the above. There have been over one thousand cases of smallpox in Minnesota since January of 1899, having the characteristics of the so-called pseudo or modified smallpox. There has been a total mortality of a trifle over 2 per cent., although in some localities with many cases there have been no deaths. Some of the fatal cases were of the acute hemorrhagic type, causing death before the fifth day. In several of these cases a correct diagnosis was not made until after death.

We can not be too careful in dealing with the present general epidemic of smallpox, and those physicians who have failed to make a correct diagnosis or who are seeking notoriety by suggesting a new name for an old disease can do much toward aiding in the suppression of the trouble by admitting their errors, or at least ceasing to preach false doctrines.

I have gone into detail thus fully in dealing with this epidemic in order that this mild type of smallpox may be placed on record for the benefit of future generations. Our special smallpox circular, issued Aug. 1, 1899, in connection with this epidemic, reads as follows:

Smallpox is prevailing all over the United States. Some of the cases are well marked and easily diagnosticated. Others are of a very mild type, and may easily be overlooked or mistaken for chicken-pox. In many cases the diagnosis of mild cases has been made possible only by their close association with undoubted cases. Since May 1st, 1899, there have been fifty cases of smallpox in Minnesota, embracing ten localities. In only one of these outbreaks was the first case a typical one. In most of the other outbreaks cases were first called chicken-pox. This diagnosis has often been persisted in even after the cases had been pronounced smallpox by experts.

Of the fifty cases of smallpox in Minnesota since May 1st but two have died. So far the disease has not been very infectious, for, with many exposures, there have been comparatively few cases; but this condition is likely to change with the on-coming of cold weather, for heavy clothing and closer association in public places will tend to produce more general infection. Every one must be on guard against this disease from now on. Railroad officials should notify their ticket agents, especially at small stations, to guard against selling tickets to persons with suspicious eruptions on the face, or with suspicious histories, unless the suspicious party can bring a certificate from a physician, known by the agent to be a reliable man, stating that the party under consideration has neither smallpox nor chicken-pox. School teachers must guard against receiving scholars with any suspicious eruption or history. Schools are probably the means of causing the spread of infectious diseases to a greater extent than any other one agent.

The time for the quarantine of smallpox should not be less than four weeks from the first appearance of the disease. Quarantine should be released thereafter on condition that the process of desquamation is complete, as determined by examination by the local health officer or his medical inspector.

Investigation tends to show that there is probably very little, if any, chicken-pox in this state at present. For this reason the state board of health, under authority given it by the law to regulate infectious diseases, requests that, for the present at least, all cases diagnosticated as chicken-pox be rigidly quarantined at their homes, or other suitable place, and reported at once to the local health officer, he without delay to report to the secretary of the state board of health (sections 18-20, chapter 132, Gen. Laws 1883).

Quarantine is for the benefit of the public, and while it may temporarily discommode a few individuals, it is an absolute necessity in order to prevent the spread of disease.

There are two systems of quarantine:

1. An honest quarantine, by a community, of all suspicious cases of infectious disease, within its limits.

2. A quarantine established by the country at large against an infected neighborhood.

The first is the more rational quarantine. There should be no occasion for general alarm and restlessness, but rather of watchfulness only, *if*, on the first appearance of some dreaded infectious disease (such as smallpox) the case, or cases, are promptly taken in charge and rigidly quarantined, and the persons who have been exposed are either kept in quarantine or under close observation until the period for the possible appearance of the disease among them has passed; *if* vaccination is carried out carefully and thoroughly; *if* the attending physician takes proper precautions against carrying the disease from the infected to the non-infected; and *if* all known methods are adopted to limit the spread of the infection.

The second is often termed "shot-gun" quarantine, and should never be necessary in well regulated communities; but it may become a necessity where the people of a village, city or township are indifferent to the interests of the surrounding country. *If* local health officers or attending physicians neglect or refuse to do their duty; *if* communities neglect or refuse to obey the instructions of the local health officer, there is but one thing left for surrounding communities to do in self-defense, viz., refuse to allow any person or thing that can possibly carry infection to pass from the infected neighborhood into a non-infected neighborhood.

Vaccination should be used as a protection against smallpox. The Minnesota State Board of Health, at its regular meeting, July 11th, 1899, took action as follows regarding vaccination:

"In view of the fact that smallpox is prevailing to so great an extent throughout the entire country, and that the danger from infection will be increased as cold weather comes on, all schools throughout the state, at the fall opening, must require a certificate of vaccination before admitting a pupil."

It is important that all health officers, school officials and teachers see that this rule is enforced this coming fall.

Sample of vaccination certificate:

Minn., ... 189. .

I hereby certify, that on the ....
day of ...., 189. . . ., I vaccinated (or examined)
....
of *No. .... Street ....
aged .... years, ... months, ... weeks, and that the evidences of successful vaccination are satisfactory.

......................................M. D.

Residence ....

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*In country districts the pupil can be designated by the examining physician as belonging to a certain family (giving name of parents).

The best vaccine virus on the market is that which will produce only vaccinia. An "old fashioned" sore arm is by no means a necessity, for such is due to septic infection and not to vaccinia. Those using glycerinated virus must not pronounce the vaccination a failure because there is no typical vesicle before the seventh or eighth day. A vaccination should not be pronounced as having failed until two weeks have passed without producing the typical symptoms.

Tuberculosis. This, a preventible disease, still continues to destroy its victims. In 1890, out of a total death rate of 14,492, in Minnesota, tuberculosis was the cause of 1,471 deaths. In 1899, out of a total death rate of 14,980, tuberculosis was the cause of 1,659 deaths. It would thus seem that the death rate from tuberculosis was slightly on the increase. This is what we would expect when no special precautions are taken to prevent infection.

It is not possible to quarantine the tuberculous individual as we do those suffering from diphtheria, for, while the type of infection is much the same in the two diseases, the one is a chronic disease and the other is acute in its nature. What, then, are we to do? We should instruct the public as to the chief sources of danger. It should be generally understood, in this enlightened age, that this disease is seldom inherited. If it involves many members of a family, it is because of the close association between the infected and noninfected. It is no uncommon thing to be able to trace the infection from wife to husband, or *vice versa*; from parent to child; from child to brother or sister.

Infection is not only from individual to individual. Tuberculous cows' milk is undoubtedly a frequent cause of this disease. There is but little danger from the careful tuberculous patient; who sleeps alone; who disinfects the sputum, if the disease is of the pulmonary form; who uses individual dishes for food and drink; who avoids kissing. The proportion of these careful individuals is very small at the present time, and will continue so to be for a long time. The most successful means of dealing with this disease will be through the general establishment of sanatoria. These may be of a private nature for those who have means, but they must be provided at public expense—federal, state, or municipal—for those of moderate means and the poor. Sanatoria should not be looked upon as places in which to bury the living. Tuberculosis is quite curable in the early stages, and may be arrested in any stage. The question may be asked: "Why establish sanatoria if the tuberculous patient can be made free from danger at home?" The answer is: Because tuberculosis is the most prevalent disease of modern times; because a certain proportion of the tuberculous will not safely dispose of their infected excretions, and hence the whole community is endangered; because the hopeless cases among the poor have no decent treatment or care, and must either die in abject neglect or go to the almshouse.

It is for these reasons that the public should demand municipal and state aid in the care of the tuberculous individual.

Sanatoria for the tuberculous are already established in Alabama, two; Colorado, three; Illinois, three; Maryland, one; Massa-

chusetts, four; New Mexico, four; New York, ten; North Carolina, two; Pennsylvania, four. The United States Army and Marine Hospital Service are doing good work with their sanatoria at Fort Bayard, N. M., and Fort Stanton, N. M., respectively.

State sanatoria should be established and maintained, partially at least, by state appropriation. Part of the expense of patients might be borne by the individuals cared for or their friends, or by the city or district from whence they came. As a matter of fact, those who have the care of the poor resting upon them (municipality or county) have already to care for many poor consumptives, in almshouses or other institutions, and the cost of such, now largely wasted by unintelligent methods, would go far towards the proper equipment and maintenance of a well regulated sanatorium. Massachusetts appropriated $150,000 in 1895 for the establishment of a "state consumption hospital." This was completed and opened Oct. 1, 1898. In the following February, its 200 beds were all occupied. The trustees decided to admit only those who were in the early stages or who gave promise of arrest or cure of the disease.

In a paper from Dr. V. G. Bowdich, reporting upon 114 patients of the first year, he states there were thirty-five cases in which the disease was "arrested," thirty-seven cases "much improved," seventeen cases "improved." The average stay in the hospital of the "arrested" and of the "much improved" cases was four months. He speaks of the "somewhat military discipline of any institution as a favorable factor in treatment." He also states that patients submit to rules of hygiene that it would be almost impossible to bring about at home, especially in the matter of fresh air.

It is not only the tuberculous patient who is benefited by the sanatoria. The lives saved from infection by the removal of these tuberculous patients from their homes and their education in hygienic living are items of great importance. In this connection it is worthy of note, as recorded by Flick, that, in studying the distribution of tuberculosis in a single ward in Philadelphia, he found that only ten per cent of the houses in which tuberculosis occurred were in an isolated position, and that in a number of years more than one, and often three or four, cases had occurred in ninety-three per cent of the infected houses.

Sanatoria for the tuberculous are becoming quite general—established by the nation, by states, by municipalities, by church organizations, by fraternal societies, etc. It was my privilege to visit an ideal home for the tuberculous, in Denver, Col., not long ago—"a place where light, airy rooms, abundance of sunshine, good food and the general comforts of home may be had at a cost within

HOME FOR THE TUBERCULOUS, DENVER, COL.

the limited means of many, and still not be a charity, * * * a place where, instead of paying two or three dollars a day, equal comforts may be had for a reasonable sum." This meets the needs of invalids of moderate means, but it cannot provide for the poor, who are as deserving of good care as are the more fortunate. This "home" consists of four buildings, one for men, one for women, one for groups of a family and one for the very sick. The accompanying illustration of this home may be of interest.

Typhoid Fever. During the preceding ten years typhoid fever killed 4,532 patients in Minnesota. With such a death rate there was, in all probability, a total of at least 50,000 additional cases of typhoid fever within the state during this same period. Taking the value of the average human life as $1,000, the average cost of caring for those ill with typhoid fever who recover at $20.00, the average value of time lost by each patient at $15.00, and we have the following as the cost to the state during the period referred to:

4,532 lives at $1,000	$4,532,000
Caring for 50,000 patients at $20.00 each	1,000,000
Time lost by 50,000 patients at $15.00 each	750,000
Total cost to the state of typhoid fever during the past ten years	$6,282,000

This is a very conservative estimate, and yet this preventible disease continues. Why? Because people are careless; because we build wells and vaults too near to each other; because we pollute our streams, our springs, and our wells with sewage. The report of the chemical survey of a portion of the southern part of the state will give some idea as to the general quality of drinking water in small villages, cities and rural districts. The history of typhoid fever at Two Harbors and at the mining districts in the northern part of the state gives evidence as to the quality of drinking water served in that section. Are we worse than other states? No; not so bad as some. Can this condition be improved? Certainly; but it takes money to make sanitary improvements, and the general ideas of those who have to do with the spending of the monies of small villages are that none can be used for sanitary purposes. Rather, it is the custom if a sewerage system is to be put in, to conduct its discharge pipe to the nearest water outlet, be it slough, lake or stream; if a water plant is to be established, to get the water from the nearest possible source, even though polluted with the sewage of the village to be supplied; if a slaughter house is to be built, to place it upon the banks of a stream, and discharge its offal into the waters, even though the drinking water or an ice supply is taken from a source near by. These seem to be quite the general ideas as to sanitation. And yet they are opposed by the laws of nature and of the state.

Are these conditions necessary? Not at all. Duluth used to be a typhoid fever center, because it discharged its sewage into practically the same part of Lake Superior that it took its public water supply from. It shifted its intake pipe to a safe distance

from its sewerage system outlet, and would now be practically typhoid fever free were it not for the cases imported from surrounding districts or the few cases still occurring among those who use polluted well water.

Minneapolis and St. Paul are but a few miles apart. The one uses a polluted river water, and is never free from typhoid fever; the other is supplied with a safe drinking water, and has an extremely low typhoid fever record, even with its imported cases.

In 1859 the city of Munich had a death rate from typhoid fever of 24.2 per thousand inhabitants. At this time it had neither sewers nor a proper water supply. Since 1859 the city has had good sewerage and a good water supply, and the typhoid fever death rate fell to 1.4 per thousand inhabitants. Is it not about time for the people of this state, through their local municipal and sanitary authorities to secure for themselves a pure drinking water? I think so.

Infantile Diarrhoeal Diseases. In this group are several forms of preventible diseases. It would seem that with increasing knowledge of hygienic and dietetic requirements mortality from these diseases should diminish. Such results seem to obtain in this state, for the annual death rate is constantly on the decrease, as shown by the following:

1893	1,248
1894	1,247
1895	1,241
1896	834
1897	885
1898	750
1899	630

Epidemic Cerebro-Spinal Meningitis. The classifying of cases of cerebro-spinal meningitis is a difficult one, and one that requires more than usual care in dealing with infectious diseases. No one, I presume, with our present knowledge will say that all cases of cerebro-spinal meningitis are of the true epidemic type. To say that the disease is epidemic in a given place when such is not the case is an error to be guarded against. In 1899 I was called upon to investigate cases of cerebro-spinal meningitis in a village of this state. The question was as to whether the disease was of the epidemic type. It had been so pronounced by some physicians, and a panicky condition prevailed among the citizens. It would have been a serious matter for me to pronounce it as belonging to the epidemic type. I had no wish to differ from attending

physicians as to the diagnosis, but I refused to commit myself without an opportunity to make a thorough investigation. This it was not possible to secure.

The reports of deaths from meningitis for 1899 and the first six months of 1900 are as follows:

1899.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total. Epidemic Cerebro-Spinal Meningitis.	Total. Cerebro-Spinal Meningitis.
Cerebro-Spinal Meningitis...	12	25	10	17	10	8	14	10	5	6	5	2	....	124
Epidemic Cerebro-Spinal Meningitis..................	7	9	4	7	6	4	....	2	....	2	1	....	42	......
1900—6 months.														
Cerebro-Spinal Meningitis...	5	4	3	3	....	5	....	....	....	....	(six	mo)	....	20
Epidemic Cerebro-Spinal Meningitis..................	2	1	....	....	2	1	....	....	....	....	(six	mo)	6	......

From this table it is plain that meningitis was quite prevalent in 1899. It is unfortunate that no opportuniy was afforded this board to make a thorough investigation of some of these outbreaks. It is altogether probable that many of the cases not designated as of the epidemic type were such.

I do not know to what extent the diagnosis of the "epidemic" type was verified by microscopic findings, but I presume this was not generally followed out. My views in relation to epidemic cerebro-spinal meningitis are so well set forth in a paper which I presented to the Minnesota Academy of Medicine, September, 1899, that I reproduce it here:

EPIDEMIC CEREBRO-SPINAL MENINGITIS.*

What is epidemic cerebro-spinal meningitis? One writer says "An infectious disease of microbic origin, in which the chief lesions are an inflammation of the meninges of the brain and spinal cord."

Osler says: "A specific infectious disease occurring sporadically and in epidemics, characterized by inflammation of the cerebro-spinal meninges and a clinical course of great irregularity."

Neiter says: "A general infectious disease whose most constant anatomical seat is the pia mater, but the effects of which are evident in all the organs. The predominance of one or the other of these aberrant localizations may become a source of complications. * * * These complications vary according to different epidemics. Thus in certain epidemics the pleural or pulmonary complications occur with such frequency that the question arises

*Read before the Minnesota Academy of Medicine, Sept. 6, 1899.

whether there is not a very close relationship between the pneumonia and the meningitis."

Some of these definitions are broad enough to cover the cerebro-spinal meningitis that may be present, as a complication, with other diseases, such as typhoid fever, pneumonia, la grippe, diphtheria, etc. Judging from the death returns, I am inclined to think that the specific disease known as epidemic cerebro-spinal meningitis has often been falsely burdened with forms of meningitis not belonging to it at all, and even with diseases not attended by meningitis.

It has been quite thoroughly established, I think, that true epidemic cerebro-spinal meningitis is due to a specific cause—the diplococcus intracellularis meningitidis. If this is true, then only should a disease be designated as epidemic cerebro-spinal meningitis when the presence of this diplococcus has been proven, either by lumbar puncture or by post-mortem findings, unless the true nature of the epidemic has already been well established and the clinical symptoms are beyond question.

This may seem to be a rather sweeping statement. It is possible that we should admit the pneumococcus as a cause, in itself, of this epidemic disease.

Osler† makes three divisions of pneumococcic meningitis:

1. As a complication of pneumonia,
2. Local infection,
3. Primary pneumococcic meningitis.

Of this last, which is the only division that could in any way be considered as a true primary cause of epidemic cerebro-spinal meningitis, Osler says:

"The records cannot be regarded as entirely trustworthy, since it is only within the past few years that bacteriologists have learned to recognize the differences between the pneumococcus and the diplococcus intracellularis."

Councilman found the diplococcus intracellularis present in thirty-one out of thirty-five post-mortems made during the epidemic in Boston and vicinity during the years of 1896-97, and of the four not showing its presence one had already given positive cultural result from the fluid obtained prior to death by lumbar puncture.

Lumbar puncture was performed in fifty-five out of the 111 cases observed by Councilman, and in thirty-eight of these fifty-five cases the diplococcus was found. The average duration of time from the onset of the disease before lumbar puncture was made was seven days in the positive cases and seventeen days in the negative. It would thus appear that delay in performing lumbar puncture may interfere with the natural findings upon which we should rely.

The diplococcus is often present in the nasal secretions from healthy individuals; hence the finding of it in cultures taken from the nose is of little or no diagnostic value. It is quite generally recognized that the disease is most prevalent in the winter and spring months. It would therefore appear that congestion or inflammation of the nasal mucous membrane might influence the entrance of this diplococcus into the system, with the natural sequel of general infection.

†Cavendish Lecture, June 16th, 1899. Philadelphia Medical Journal, July 1st, 1899, p. 26 et seq.

It is well known that the diplococcus pneumoniae is often present in cases diagnosticated as epidemic cerebro-spinal meningitis; also, that cerebro-spinal meningitis may exist as a sequel of typhoidal, diphtheritic, strepto-coccic, or other infection. Should any of these diseases be epidemic in type, the meningitis might have the appearance of an epidemic disease; but this would not represent what we mean to express when we speak of epidemic cerebro-spinal meningitis. We must therefore be on our guard against such errors.

Bearing in mind the frequent presence of the diplococcus intracellularis in the nasal cavity, we need not be surprised at possibly having a mixed infection, as an accompaniment of influenza of the epidemic, or non-epidemic type. This possibility was strongly impressed upon me last winter, in a community where a number of fatal cases, diagnosticated as epidemic cerebro-spinal meningitis, occurred. In the history of the few cases that I obtained, the possibility of the disease having been at the outset epidemic influenza (la grippe) was strongly suggested, while the sudden change in the character of the disease, followed by death, gave rise, in some cases, to a change in diagnosis by the attending physician. Unfortunately it was not made possible to prove by culture the presence or absence of the diplococcus intracellularis. It therefore remains an open question whether these cases were meningitis, due to infection from the germs of influenza, or a true epidemic cerebro-spinal meningitis following epidemic influenza, or true epidemic cerebro-spinal meningitis from the outset.

Councilman says: "The classification of a disease should always be made from an aetiological point of view. The recognition of a definite infectious agent establishes the identity of a disease. In the absence of this a definite class of symptoms, based on certain anatomical lesions, is our only method of classification. The insufficiency of this latter method of classification is shown by the fact that before the recognition of the infectious agent causing epidemic cerebro-spinal meningitis there was no way of separating sporadic cases and small epidemics of this disease from meningitis caused by other infectious agents."

Osler, in the lecture already referred to, states that "an aetiological classification, possible to-day in part, is of necessity incomplete." He then gives a "provisional grouping" as follows:

Acute Lepto-Meningitis.	Primary.	1. Of cerebro spinal fever	(a) sporadic (b) epidemic	Diplococcus intracellularis.
		2. Pneumococcic	Meninges alone involved or a general pneumococcus infection.	Pneumococcus.
	Secondary.	1. Tuberculous	. . . .	Bacillus tuberculosis.
		2. Pneumococcic	(a) Secondary to pneumonia, endocarditis, etc. (b) Secondary to disease or injury of cranium, or its fossa.	Pneumococcus.
		3. Pyogenic	(a) Following local disease of cranium or a local infection elsewhere. (b) Terminal infection in various chronic maladies.	Various forms of staphylococci and streptococci.
		4. Miscellaneous acute infections.	In typhoid fever, influenza, diphtheria, gonorrhea, anthrax, actinomycosis and other acute diseases.	Typhoid bacillus, Influenza bacillus, Diphtheria bacillus. Gonococcus, etc.

This certainly is the best working classification that we have at present, and is capable of extension indefinitely.

It is the sporadic cases and small epidemics that have confused us in the past, but they should do so no longer. The appearance of such suspicious cases in any community should be the signal for immediate and thorough examination, both clinically and culturally.

Minnesota, as shown by the death records, has had many of these confusing cases during the past year or more. Very seldom has the clinical diagnosis been verified culturally, and in some cases, at least, there was a strong probability of the disease being dependent upon some other epidemic disease.

Councilman says: "It seems probable that there must be a large number of sporadic cases of epidemic meningitis constantly occurring, which, under certain conditions, the nature of which we are not aware of, may so increase in number as to form an epidemic. Nothing can be learned with regard to these cases from an examination of mortality tables. They show rather that the disease is very frequently not recognized when it occurs, and that many cases are reported as meningitis which are not so. The large percentage of cases under one year in such tables show how unreliable they are."

Epidemic cerebro-spinal meningitis has received careful study during the past century. It was first recognized in this country as an independent disease in 1806. Since then some of the most indefatigable workers in its investigation have been connected either with the Massachusetts State Medical Society or the Massachusetts State Board of Health.*

An error in diagnosis may be of small matter to the diagnostician, and even to the patient, in differentiating the true epidemic form from other forms of cerebro-spinal meningitis. Not so with the sanitarian and the people at large. The announcement of the prevalence of an epidemic disease of such grave character and attended by such a high mortality as is true epidemic cerebro-spinal meningitis is sufficient to spread panic through the whole community, and to cause, through suggestion and fear, an increased tendency to disease, and even death. It also has a demoralizing effect upon commercial interests.

The conclusions to be drawn from this paper are as follows:

1. We should not class all forms of cerebro-spinal meningitis as of the true epidemic type,

2. We should not class cerebro-spinal meningitis, occurring as a complication or sequela of certain epidemic diseases, such as typhoid fever, la grippe, pneumonia, etc., as epidemic;

3. We should be very guarded in diagnosticating any given case of cerebro-spinal meningitis as epidemic;

4. The prevention of error in diagnosticating epidemic cerebro-spinal meningitis should be avoided by a microscopical examination of fluid removed by lumbar puncture during life, when possible, or by post-mortem findings.

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*Danielson & Mann, Agricultural Register, 1806.
Medical Com. to Mass. Med. Society, 1809, James Jackson, Sec.
Elisha North (classical paper), 1811, Goshon, Conn.
Upham, Newburne, N. C., 1863.
Upham, Mass. State Board of Health, 1874.
Committee Mass. Medical Society, 1865.
Webber (Boylston Prize Essay), 1866.
Flexner & Barker, Penn. State Board of Health, 1894.
Councilman, Mallory & Wright, Mass, State Board of Health, 1898.

Cancer: Considerable study has been given recently by medical men to a group of diseases under this title. The question is often asked, Is cancer becoming more widely spread? There are no available statistics in Minnesota bearing upon this question, so far as I am aware, except those given in the death reports, which are as follows:

1890	339
1891	328
1892	396
1893	419
1894	404
1895	476
1896	514
1897	514
1898	558
1899	545
1900 (9 months)	427

Of course, our constantly increasing population must be kept in mind when reading the above figures. It will then be seen that there has been no material increase in the state of deaths from cancer.

Leprosy. Patients ill with this disease in Minnesota are kept under observation by the Minnesota state board of health, and directions are given looking towards the prevention of its spread. So far we can report that we have no knowledge of an American-born leper in the northwestern group of states, although there have been many imported cases from Norway, Sweden, Iceland and China. Two years ago the American Public Health Association appointed a committee to investigate and report upon the advisability of establishing national leprosaria in the United States. The following paper was presented by me, as chairman of the aforesaid committee, to the association, at its meeting in Indianapolis, October, 1900. This report was kindly received, and the resolutions suggested in it were adopted:

ARE NATIONAL LEPROSARIA IN THE UNITED STATES DESIRABLE?

By H. M. Bracken, M. D.

Secretary and Executive Officer Minnesota State Board of Health.

In order to answer this question intelligently it is necessary to make a careful study of leprosy. Early in the year I sent a circular letter to the various provincial and state sanitary authorities asking for information regarding leprosy within their jurisdictions, and also asking their opinion as to the best method of caring for lepers.

The information returned is given in condensed form in the following table:

Name of Province or State.	Is there any Record of Lepers within your Jurisdiction?	How Have They been Cared For?	What Future System for the Care of Lepers would you Suggest?	Name of Reporter.
Manitoba	Yes.	At a national lazaretto	National	
New Brunswick	Yes.		"	
Nova Scotia	Yes.		"	Dr. A. P. Reid.
Ontario	No.		"	Dr. P. H. Bryce.
Quebec	No.		"	Dr. E. Pelletier.
Arkansas	No.	No system	"	Dr. R. B. Christian.
California	Yes.	County care	"	Dr. W. P. Mathews.
Colorado	No.	No system	"	Dr. G. E. Tyler.
Connecticut	No.	" "	National or state	Dr. C. A. Lindsley.
Delaware	No.	" "	National	Dr. A. I. Lowber.
Illinois	No.	" "	State and national	Dr. J. A. Egan.
Indiana	No.	" "	National	Dr. J. N. Hurty.
Iowa	Yes.	Isolation at home	National	Dr. J. F. Kennedy.
Kansas	No.	No system	"	Dr. W. B. Swan.
Kentucky	No.	" "	County care	Dr. J.N. McCormack.
Louisiana	Yes.	State care	National	Dr. G. F. Patton.
Maine	No.	No system	"	Dr. A. G. Young.
Maryland	Yes.	" "	"	Dr. J. S. Fulton.
Massachusetts	No.	" "	National or state	Dr. S. W. Abbott.
Michigan	No.	" "	No suggestion to offer	Dr. H. B. Baker.
Minnesota	Yes.	Isolation at home	National	Dr. H. M. Bracken.
Mississippi	No.	No system	"	Dr. J. F. Hunter.
Nebraska	No.	" "	"	Dr. F. B. Crummer.
NewHampshire	No.	" "	No suggestion to offer	Dr. I. A. Watson.
New Jersey	Yes.	County care	No suggestion to offer	Dr. H. F. Mitchell.
New Mexico	No.	No system	National	Dr. T. P. Martin.
New York	Yes.	" "	Probably national.	Dr. B. F. Smelzer.
North Carolina	No.	" "	National	Dr. R. H. Lewis.
North Dakota	Yes.	County care	"	Dr. H. D. Quarry.
Ohio	Yes.	No system	"	Dr. C. O. Probst.
Oklahoma	No.	" "	"	Dr. L. H. Buxton.
Pennsylvania	Yes.	City	"	Dr. Benj. Lee.
Rhode Island	No.	No system	National or state	Dr. G. T. Swartz.
South Carolina	Yes.	" "	No suggestion to offer	Dr. T. G. Simons.
South Dakota	Yes.	County	National	Dr. A. E. Clough.
Tennessee	No.	No system	"	Dr. J. A. Albright.
Texas	Yes.	Sent to Louisiana	State	Dr. W. T. Blunt.
Vermont	No.	No system	National	Dr. J. H. Hamilton.
Virginia	No.	" "	"	Dr. P. A. Irving.
Wisconsin	Yes.	Isolation at home	"	Dr. U. O. B.Wingate.

Three provinces and fourteen states report having had lepers to deal with. Other states undoubtedly belong in this list. It has been possible for me to make a somewhat careful study of leprosy in the Northwest. This report will therefore be given in four parts. The first part will relate to cases of leprosy reported officially from five states, viz., Iowa, Wisconsin, Minnesota, North Dakota and South Dakota. The second part will relate to the cases of leprosy reported officially from a few other states. The third part will give the history of a few cases of leprosy of which I have knowledge through private information. The fourth class includes five cases, some of whom may have been already reported in parts one or three. The possibility of duplication in dealing with these cases is so strong that I have preferred reporting them as a distinct class. The location in which the official cases have, or had, residence will be given. The non-official cases, for evident reasons, cannot be located.

Part I.--Lepers reported officially from Iowa, Wisconsin, Minnesota, South and North Dakota.

No.	State.	Nationality.	Disease Appeared Abroad.	Date of Birth.	Date of Death.	Type of Disease.	Pecuniary Condition.	Initial of Patient.
1.	Iowa..	Norwegian..	Yes...	1880	1899	Tubercular..	Good.	C. P.
2.	"	"	"	......	......	....	......	
3.	"	"	"	......	......	....	......	
4.	Wis...	"	"	......	......	....	......	M. M.
5.	"	"	"	......	1897	Tubercular..	Poor..	H. O. G.
6.	"	"	......	......	......	....	......	O. S.
7.	"	"	......	......	......	....	......	G.
8.	"	"	......	......	1898	Anæsthetic..	Poor..	T. L.
9.	"	"	Yes...	1839	L'v'ng	"	Good.	J. P.
10.	"	Swedish....	"	1853	"	Tubercular..	"	A. M. L.
11.	Minn.	Norwegian..	"	1831	1880	Anæsthetic..	......	
12.	"	"	"	1822	1878	Tubercular..	......	
13.	"	"	No...	1843	1878	Anæsthetic..	......	
14.	"	"	"	1846	1876	Tubercular..	Good.	K. A.
15.	"	"	"	1848	1878	"	"	T. A.
16.	"	"	Yes...	1815	1877	"	......	
17.	"	"	"	1848	1868	Anæsthetic..	......	
18.	"	"	No ...	1825	1885	"	......	
19.	"	"	"	1854	1885	Tubercular..	......	
20.	"	"	"	1839	1884	Anæsthetic..	Poor..	
21.	"	Swedish....	"	1853	1886	"	......	
22.	"	Norwegian..	"	1826	1888	....	......	
23.	"	"	......	1851	1888	Tubercular..	Poor..	
24.	"	Swedish....	Yes...	1831	1889	"	Fair..	O. E.

Part I.—*Continued.*—Lepers reported officially from Iowa, Wisconsin, South Dakota and North Dakota.

No.	State.	Nationality.	Disease Appeared Abroad.	Date of Birth.	Date of Death.	Type of Disease.	Pecuniary Condition.	Initial of Patient.
25.	Minn.	Norwegian..	No ...	1862	1889	Tubercular..	Poor..	S. B.
26.	' '	' '	Yes...	1849	1890	Anæsthetic..	' '	E. N.
27.	' '	' '	' '	1842	1890	Tubercular..	......	C. K.
28.	' '	' '	......	1816	1896	' '	Fair..	O. H.
29.	' '	' '	......	1814	1892	' '	' '	E. A.
30.	' '	' '	Yes...	1830	1899	Anæsthetic..	Good.	J. P. S.
31.	' '	' '	' '	1840	1896	' '	Poor,.	C. J. K.
32.	' '	' '	' '	1848	1896	' '	......	T. N.
33.	' '	' '	' '	1820	L'v'ng	' '	Poor..	H. O. S.
34.	' '	' '	......	1834	1900	Tubercular..	Good.	A. B.
35.	' '	' '	......	1857	1894	' '	......	N. O. H.
36.	' '	' '	Yes...	1838	189.	' '	Good.	M. J. M.
37.	' '	' '	' '	1840	L'v'ng	Anæsthetic..	Poor..	A. M.
38.	' '	' '	' '	1843	1897	' '	......	J. I. S.
39.	' '	' '	......	1864	1899	Tubercular..	Fair..	I. J. P.
40.	' '	' '	Yes...	1850	189.	Mixed......	Poor..	J. S.
41.	' '	' '	......	1850	1892	Tubercular..	......	A. R.
42.	' '	' '	......	1826	1895	Anæsthetic..	Poor..	M. T.
43.	' '	' '	......	......	189.	' '	......	H. G.
44.	' '	' '	Yes...	1871	189.	Tubercular..	Poor..	G. H. B.
45.	' '	' '	......	1851	189.	' '	' '	J. O. B.
46.	' '	' '	......	1867	L'v'ng	' '	' '	J. T. H.
47.	' '	' '	Yes...	1852	Dead..	' '	......	L. P. V.
48.	' '	' '	......	1860	L'v'ng	Anæsthetic..	Fair..	F. E. M.
49.	' '	' '	Yes...	1853	1897	Tubercular..	Poor..	F. J. R.
50.	' '	Swedish....	' '	1845	1894	' '	......	B. F.
51.	' '	' '	' '	1845	1897	' '	Good.	A. M. O.
52.	' '	Norwegian..	......	1860	Gone.	Mixed......	Fair..	J. M.
53.	' '	Swedish....	......	1865	L'v'ng	Tubercular..	Poor..	M. H. D.
54.	' '	Norwegian..	......	1867	1897	Anæsthetic..	' '	I. H. W.
55.	' '	' '	......	1843	L'v'ng	Mixed......	Fair..	L. B.
56.	' '	Swedish....	......	1861	' '	Tubercular..	' '	O. G. E.
57.	' '	' '	......	1858	' '	Mixed......	Good.	J. P. L.
58.	' '	Norwegian..	Yes...	1862	1890	Anæsthetic..	' '	B. O.
59.	' '	Swedish....	......	1845	1900	Mixed......	Fair..	C. P.
60.	' '	Norwegian..	Yes...	1863	1898	Tubercular..	Good.	L. B.
61.	' '	' '	......	1843	L'v'ng	' '	......	E. J.
62.	' '	' '	No ...	1856	' '	Mixed......	Poor..	O. K. K.
63.	' '	Swedish....	' '	1856	' '	' '	' '	J. E.
64.	' '	Norwegian .	' '	1845	' '	Tubercular..	Good.	O. T.
65.	' '	' '	Yes...	......	' '	Mixed......	Fair..	C. D. D.
66.	' '	' '	' '	1828	1899	Anæsthetic..	Poor..	O. J.
67.	' '	' '	' '	1856	1898	Tubercular..	Fair..	G. P.
68.	' '	' '	......	......	L'v'ng	' '	......	O. T.
69.	' '	' '	Yes...	1869	' '	' '	Fair..	M. A.
70.	' '	' '	No ...	......	1895	' '	Good.	C. N.
71.	' '	' '	Yes...	......	Gone.	Anæsthetic..	Fair..	G. A.
72.	S. D..	' '	......	1878	L'v'ng	Tubercular..	Poor..	B. T.
73.	N. D.	' '	......	1847	' '	' '	' '	S. A.
74.	' '	Swedish....	......	1870	' '	' '	' '	J. O.
74*a*	' '	Norwegian..	......	1886	' '	Not Leprosy	Good.	E. B.

Part II.—Lepers reported officially from other states than above.

75.	Pa....	Maryland,..	......	......	1900	Tubercular..	Poor..	M. S.
76.	"	Pennsylv....	......	1822	L'v'ng	Mixed......	"	C. P.
77.	"	Swedish...	......	1850	1900	Tubercular..	"	J. A.
78.	"	Pennsylv....	......	1856	1900	"	"	A. D. W.
79.	"	Chinese	......	......	1897	....	"	H. Y.
80.	"	"	......	......	Dead..	Tubercular..	"	J. W.
81.	N. J..	"	......	......	"	....	......	
82.	Ohio..	?	......	......	......	....	......	

Part III.—Unofficial list of Lepers.

No.	NATIONALITY.	No.	NATIONALITY.	No.	NATIONALITY.
1.	Mexican.	10.	Icelandic.	19.	Icelandic.
2.	American.	11.	"	20.	"
3.	Chinese.	12.	"	21.	"
4.	Greek.	13.	"	22.	Chinese,
5.	Norwegian.	14.	"	23.	Norwegian.
6.	"	15.	"	24.	"
7.	"	16.	"	25.	"
8.	"	17.	"		
9.	"	18.	"		

Part IV.—Possible Duplicates.

No.	NATIONALITY.	No.	NATIONALITY.	No.	NATIONALITY.
A.	Norwegian.	C.	Icelandic. ?	E.	Chinaman.
B.	"	D.	"		

SUMMARY OF CASES REPORTED.

Official..	82
Non-official..	25
Possible duplicates..	5
Total..	112

OFFICIAL LIST OF LEPERS.

Case 1. This patient's mother was recognized as leprous two years before she gave birth to this child, and was placed in a leprosarium in Norway, where she died four years after her disease was recognized. The father married again (whether in Norway or the United States is not stated), and settled on a farm in Iowa. Tubercular leprosy appeared in this child when six years old, and she died at the age of eighteen. She lived at home, and, although quite strictly isolated, was probably better cared for and happier than she could possibly have been in a leprosarium. She slept and ate by herself, but was not excluded entirely from association with other members of the family.

Dead. Tubercular. Twelve years. Home care good.

Neither an older sister (born before the mother showed evidences of the disease) nor stepsisters have leprosy.

Cases 2, 3 *and* 4. I have so far been unable to obtain a full record of these cases.

Case 5. This man, a Norwegian, died in 1897. He was married, and his widow and children (four) are living and healthy. He came to America about 1884, and showed slight symptoms of tubercular leprosy at that time. His general condition towards the end was bad. He was a county charge, and there was more or less complaint in the community concerning the methods of quarantine pursued. His life was not made more tolerable by such unnecessary complaints.

Dead. Tubercular. Twelve years or more. Leprosarium.

Cases 6 *and* 7. Of these I have no records.

Case 8. This man, a Norwegian, died in 1898. His age at the time of death is not given. His mother was recognized as leprous when he was twelve years old. His was of the anæsthetic type. He was poor and a county charge; was never married. He was a sufferer for years. Undoubtedly his life might have been made more tolerable had he been properly cared for.

Dead. Anæsthetic. Poor. Leprosarium.

Case 9. This man, a Norwegian, still living, is about sixty-six years old. He is married and has several grown children. The wife and children are all free from leprosy. His is the anæsthetic form of the disease, and has been

Living. Anæsthetic.

Twenty-five years. Comfortable at home.

present for probably twenty-five years. His hands and one foot are deformed. One leg has been amputated, and the sight of one eye is lost. Financially he is comfortably well off, and is cared for by his wife and married daughter.

Living. Tubercular. Life. Comfortable at home.

Case 10. A Swedish woman, still living, aged forty-two years. She is said to be single, and to have the tubercular form of the disease, which is now in the advanced stage. She is said to have had leprosy since birth. She is cared for at her home, in a secluded manner, and is comfortable.

Dead. Anæsthetic. Twenty-four years.

Case 11. A male (Norwegian), died at the age of forty-nine, in 1880. His was the anæsthetic form of leprosy, from which he is said to have suffered for a period of twenty-four years. He was resident in the United States nineteen years. The financial condition or general surroundings of this patient are not known. One maternal great-uncle was leprous.

Dead. Tubercular. Fourteen years.

Case 12. A male (Norwegian) died at the age of fifty-six, in the year 1878. He is said to have had the tubercular type of leprosy, and is also said to have been ill fourteen years, the disease appearing, according to the records, ten years after his arrival in this country. Nothing is known of this man's financial condition or the system pursued in caring for him. He had a leprous cousin, but no other leprous relatives are noted.

Dead. Anæsthetic. Ten years.

Case 13. A male (Norwegian) died at the age of thirty-five, in 1878. He had the anæsthetic type of the disease for a period of ten years, nine of which were said to have been spent in this country. Nothing is known of the financial condition or care given this patient. A paternal uncle was recognized as leprous.

All dead. All tubercular leprosy.

Cases 14, 15 *and* 29. These may well be considered together. They were three brothers, born in Norway. The father died of leprosy. In 1864 an older brother sent for his widowed mother and her other children (three sons and one daughter) to come to Minnesota. These three sons all died of tubercular leprosy, one in 1876 (Case 14), the second in 1878 (Case 15), and the third in 1892 (Case 29). The first two were married, but left no children. Both widows married, and are still living and well. The third case was never married. The first two were prob-

ably as well cared for at their homes, on a farm, as they could possibly have been at a leprosarium. The third lived in a small city. He had been in business, and was a general favorite. When the disease became well marked and revolting he was tolerated as a stranger would not have been. The mother, the oldest brother and the sister (younger than Cases 14 and 15) escaped infection. The mother died at the age of eighty-seven. The brother and sister are still living. **Comfortable at home.**

Case 16. This man, a Norwegian, died at the age of sixty-two, in 1877. His disease was recognized as of the mixed type. It had existed for a period of thirty years, the last twenty-one of which were passed in this country. Nothing is known of the surroundings or care of this patient. His brother and a paternal uncle were recognized as lepers, living presumably in Norway. **Dead. Mixed. Thirty years.**

Case 17. This man, a Norwegian, died at the age of thirty, in 1878. His disease was of the anæsthetic type. Its duration is not given, neither have we any knowledge of the care he received or of his surroundings. A maternal uncle is said to have been leprous. **Dead. Anæsthetic.**

Case 18. This man, a Norwegian, died at the age of sixty, in 1885. He was one of the lepers seen by Prof. Wm. Boeck of Christiana when here in 1869-70. His was the anæsthetic form of the disease, and it had existed for a period of at least twenty years. He was resident in the United States twenty-nine years. **Dead. Anæsthetic. Twenty years.**

There is no further record of this case, except that he belonged to a decidedly leprous family in Norway, his father, a paternal aunt, brothers, sisters and cousins being recognized as leprous.

Case 19. This patient, a woman, died at the age of thirty-one, in 1885. Her nationality is not given, but she was presumably a Norwegian. The disease was of the tubercular form, and is noted as having been present for nine years, and having made itself manifest nine years after she came to America. She was in the United States eighteen years. Nothing more in the history of this case is given. **Dead. Tubercular. Nine years.**

Case 20. This man died at the age of forty-one, in 1885. His nationality is not given, but he was presumably a Norwegian. His was the anæsthetic form of leprosy, **Dead. Anæsthetic.**

Eleven years. and the records state that it was recognized eleven years before his death. He was resident in the United States sixteen years. Nothing more is known of this case.

Dead. Anæsthetic. Ten years. Leprosarium. *Case* 21. This man, from Sweden, died at the age of thirty-four years, in 1886. His was the anæsthetic form of the disease, and its duration is said to have been about ten years. He became a county charge. He was not married.

Dead. *Case* 22. Of this man there is no record, further than that he was a Norwegian, that he died at the age of sixty-two, in 1888, and that he was married. His home had been in the country.

Dead. Tubercular. Poor. Comfortable at home. *Case* 23. This man, a Norwegian, died at the age of thirty-seven, in 1888. His was the tubercular form of leprosy. The duration of the disease is not known. He was poor and had some financial aid from the city in which he lived, but he remained at home and was well cared for by his wife. The attending physician informs me that the patient had two children, aged respectively about fourteen and fifteen years, both bright and in attendance at the public schools. His home was a sample of neatness. Neither his wife nor children showed any evidences of the disease.

Dead. Tubercular. Eighteen years. *Case* 24. This man, a Swede, died at the age of fifty-eight years, in 1889. His was probably the tubercular form of the disease, although it is not so stated by the reporter. He was married, and of his eight children seven are still living, ranging from twenty to forty years of age. The widow is also still living. None of these show any signs of leprosy. He was cared for at home. No facts are available as to his financial condition or general surroundings during his long illness. It is said that the disease was recognized soon after his arrival in this country, in 1881.

Dead. Tubercular. Poor. Leprosarium. *Case* 25. This man, a Norwegian, died at the age of twenty-seven, in 1889. His was the tubercular form of the disease. It is not known how long the disease existed. The man was single and of the ne'er-do-well type. When he became helpless he became a county charge, and died in a "pesthouse," where the care given him was not that of a modern hospital

Dead. Anæsthetic. *Case* 26. This man, a Norwegian, died at the age of fifty-one years, in 1890. His was the anæsthetic form of

the disease. The disease is said to have been present for twelve years. There is no record of this man or his surroundings, further than that he was married. His death certificate was signed by a coroner, so I presume a properly equipped and conducted leprosarium might have been an improvement upon the place in which he spent his last days. Twelve years. Leprosarium.

Case 27. Of this man there is no record further than that he was a Norwegian, and died at the age of forty-eight, in 1890. His was the tubercular form of the disease, said to have been in existence thirty years, and to have appeared twelve years before he came to America. Dead. Tubercular. Thirty years.

Case 28. This man, a Norwegian, died at the age of seventy-nine years, in 1895. His was the tubercular form of the disease. It was recognized first twenty-two years before his death, and seven years after his landing in America. Dead. Tubercular. Twenty-two years.

He had a comfortable home and was well cared for. Five children are living, none of whom show any signs of the disease. Comfortable at home.

Case 30. This man, a Norwegian, died at the age of sixty-nine, in 1899. His was the anæsthetic form of the disease. He came to America in 1874, and had been recognized as leprous since 1860. He is said to have been self-supporting. I have no knowledge of his surroundings or general care. Dead. Anæsthetic. Thirty-nine years. Self-supporting.

Case 31. This man, a Norwegian, died at the age of fifty-six years, in 1896. His was the mixed form. The disease is said to have first appeared in 1858. He came to America in 1871. He was a single man, and lived alone in a hut not far from his brother. He is described as having been "hideous" to look upon. Both lips, the nose and all of the fingers were gone. Both lower eyelids were everted. Tubercles were present in various parts of the body. The latter days of this patient must have been of a character hard to realize. Truly a leprosarium would have been a blessing to him. Dead. Anæsthetic; later tubercular. Thirty-eight years. Poor. Leprosarium.

Other members of this man's family showed no evidences of the disease.

Case 32. This man, a Norwegian, died at the age of forty-eight, in 1896. His was the anæsthetic form of the disease. There is no record of its duration or of the gen- Dead. Anæsthetic.

eral surroundings of the patient. His father died a leper in this country (Case A, page 22), as did also one brother (Case 70). He left a widow and five children, none of whom have ever shown evidence of the disease.

Living. Anæsthetic. Poor. Leprosarium.

Case 33. This man, a Norwegian, is still living, at the age of eighty (1900). His is the anæsthetic form of the disease. He has been a sufferer for many years, and is most emphatically a case for a well-cared-for leprosarium.

Dead. Tubercular. Sixteen years. Comfortable at home.

Case 34. This man, a Norwegian, died at the age of sixty-six years, early in 1900. His was the tubercular form of the disease, and had been known to exist for sixteen years. He was a farmer, in comfortable circumstances, and was well cared for by his wife and one son, who lived at home when I visited him in 1899. His room was neat and well kept. He was as comfortable as possible for one confined to bed with tuberculur leprosy to be. The disease was loathsome to look upon. At present his widow and six children (all grown) are living. None of these show any signs of leprosy.

Dead. Tubercular. Nine years.

Case 35. This man, a Norwegian, died at the age of thirty-seven years, in 1894. His was the tubercular form of the disease, and had been present for at least nine years. There is no record of this man or his surroundings, but it is probable that he was living on a farm and was taken care of at home. His wife and three children were reported as free from any evidences of this disease in 1898.

Dead. Tubercular. Ten years.

Case 36. This man, a Norwegian, died at the age of about fifty-three years. His was of the tubercular form. Nothing is known of the care he received, but probably he was well cared for at home. He was ill about ten years. His wife and two daughters were reported as in good health in 1898. Both daughters are school teachers.

Living. Anæsthetic. Thirty years. Leprosarium.

Case 37. This woman, a Norwegian, is still living, at the age of sixty years. The disease is of the anæsthetic type and is said to have been present since 1870. She is not careful or cleanly in her habits, and is a proper case for a well-regulated leprosarium. She came to Minnesota from Wisconsin.

Dead. Anæsthetic. Twelve years.

Case 38. This man, a Norwegian, died at the age of fifty-three, in 1897. His was the anæsthetic form of the disease, and was known to have been present for twelve

years before his death. I have no history of his surroundings. His wife and three children were reported in 1898 as free from any evidences of leprosy.

Case 39. This man, a Norwegian, died at the age of thirty-five, in 1899. His was the tubercular form of the disease, and it is said to have first appeared in 1882. Although a leper, he, a laboring man, took care of himself in a city until shortly before his death. Dead. Tubercular. Seventeen years. Leprosarium.

Case 40. This man, a Norwegian, died when over fifty years of age, some time after 1890. His was probably the mixed form of the disease, and was of long standing. He was poor and should have been cared for in a leprosarium. His widow married again. She and his child (a boy) have never shown any evidences of this disease. Dead. Mixed. Leprosarium.

Case 41. This woman, a Norwegian, died at the age of forty-two, in 1892. Hers was the tubercular form of the disease. She was married, but there is no record of her having had any children. The disease is said to have been present for eighteen years. Nothing is recorded as to how she was cared for. Dead. Tubercular. Eighteen years.

Case 42. This man, probably a Norwegian, died at the age of sixty-nine, in 1895. His was the anæsthetic type of the disease. It had been known to be present for at least twenty years. He was a county charge for many years, and a leprosarium would have been the proper place for him. He was not married. Dead. Anæsthetic. Twenty years. Poor. Leprosarium.

Case 43. This woman, probably a Norwegian, died some time after 1890. Hers was the anæsthetic form of the disease. Its duration is not known, nor do the records show how old she was at the time of death. She came to Minnesota from Wisconsin. She was married and had three or four children, all of whom were reported healthy in 1898. Her general surroundings are not recorded. Dead. Anæsthetic.

Case 44. This woman, a Norwegian, was a leper when she came to America in 1890. After staying here two or three years she returned to Norway, where she died. She was single. There is no record as to how she was cared for in this country. She is said to have been poor. Dead. Tubercular. Poor. Leprosarium.

Case 45. This man, a Norwegian, was recognized as leprous about 1886. He was then thirty-five years old, and had been in America about four years. He was mar- Dead. Poor.

Tuberculous. Leprosarium.

ried and had at that time three or four children living. His was the tuberculous form of the disease. He was poor. About 1892 he was sent back to Norway, where he died later.

Living. Tubercular. Leprosarium.

Case 46. This man, a Norwegian, is still living. He was born in 1867, and was known to be leprous in 1890. His is the anæsthetic form of the disease. He is single and poor, and should be in a leprosarium.

Dead. Tubercular. Leprosarium.

Case 47. Of this man, a Norwegian, but little is known. His was the tubercular form of the disease. He was first reported to the Minnesota State Board of Health as leprous in 1892. He had then been unable to work for four years. The disease is said to have appeared in 1884, the same year that he landed in America. This means simply that he came to America a leper. In all probability he is dead, for repeated attempts have failed to find him. There is no record as to his pecuniary condition. He was born in 1852.

Living. Anæsthetic.

Case 48. This man, a Norwegian, is possibly living still, but it has been impossible to get any trace of him during the past three years. He was born in 1860, and was recognized as leprous in 1890. He was then a married man, with a wife and three healthy children. He is said to have been in comfortable circumstances, and to have had the disease in mild form—anæsthetic.

Dead. Tubercular. Twenty-four years. Poor. Leprosarium.

Case 49. This man, a Norwegian, died at the age of forty-four, in 1897. His was the tubercular form of the disease. It had been recognized as present for at least twenty-four years. He was poor and a proper case for a leprosarium. He was single.

Dead. Tubercular.

Case 50. This woman, from Sweden, died at the age of forty-seven, in 1894. She was recognized by a noted leprologist as leprous in 1893, the disease being of the tuberculous type. In spite of this the physician who attended her in her last illness (pneumonia) stated that he did not think she had leprosy. This simply illustrates the ease with which the disease may be passed over by the ordinary practitioner. She was married and had six children, all of whom were in good health in 1898. There is no record of her financial condition or the means employed to care for her.

Dead.

Case 51. This man, from Sweden, died at the age of fifty-two, in 1897. The disease is said to have first ap-

peared in 1892. It was of the tubercular type. He was comfortably fixed financially, and was well cared for at home. He left a widow and four or five children, all reported healthy in 1898. Tubercular. Five years. Comfortable at home.

Case 52. This man, a Norwegian, was born in 1860, and was recognized as a leper in 1889. He lived in Chicago at one time, but came to Minnesota for treatment by a Norwegian physician familiar with leprosy. His was of the tubercular type. He had a hard experience when he first came to Minnesota. He was practically chased from one place to another, until finally concealed for a time. The people tried to send him back to Chicago, but the car in which he was traveling was sidetracked at La Crosse, and from here he was finally removed by wagon a distance of over one hundred miles, into a safe place, and under the care of a kind-hearted physician. The physician who had him in charge died, and it is said the patient then found his way to Norway and entered a leprosery. Whether he is still living is not known. He has sufficient means to pay his way comfortably, and if he had not been persecuted his life might have been made tolerable. His case illustrates the needs of leprosaria as a refuge for unfortunates. Gone. Tubercular. Leprosarium.

Case 53. This woman, from Sweden, was born in 1865, and is still alive. She came to America in 1887, and soon afterward married a Norwegian. In 1889 leprosy appeared. She is an exceedingly neat woman, and does everything in her power to prevent any possible infection of her family. Hers is the tubercular form of the disease. She has four children, two born before the disease appeared, two since. All of these, as well as the husband, were free from any symptoms of leprosy when seen by me in March, 1897. The oldest child was of age to enter the public school, but the sentiment against leprosy was so great as to exclude her, although perfectly well. The husband was a carpenter, and it was almost an impossibility for him to secure work because of his wife's disease. The poor woman was longing for death to come in order that the persecution of her family on her account might cease, but she is still suffering, not only physically but mentally. What a refuge a leprosarium Living. Tubercular. Poor. Leprosarium

would have been to this poor woman! She would then not only have had good medical care and nursing, but the ostracism of her family would have ceased.

Dead. Anæsthetic. Poor. Leprosarium.

Case 54. This man, a Norwegian, died at the age of thirty, in 1897. His was the anæsthetic form of the disease. The records show nothing for this man further than that he was single and poor. Undoubtedly a leprosarium would have been the proper place for him.

Living. Anæsthetic. Poor. Leprosarium.

Case 55. This man, a Norwegian, is still living, aged fifty-seven years. He has the anæsthetic form of the disease, which first made its appearance in 1874 or earlier. He is single and a county charge. When first seen by me, in 1898, he was serving as a school janitor, but when the nature of his disease became known he could no longer get employment. He is much crippled. A leprosarium would be a great blessing to this man. He says he had no leprous relations, but had leprous neighbors in Norway.

Living. Tubercular. Poor. Leprosarium.

Case 56. This man, from Sweden, is living, aged thirty-nine years, and is able to support himself; but the time will soon come when he will become a public charge, and then he will probably be given the privilege of dying at a "pesthouse." His is the tubercular form of the disease. It made its first appearance in 1892, and was then diagnosed as syphilis. He has a wife and two children, aged thirteen and ten years, all living and free from any symptoms of leprosy. A leprosarium will be the proper place for this man soon, although his condition has not changed much for the worse during the past two and a half years. He was associated with lepers as a lumberman in Sweden.

Living. Tubercular. Comfortable.

Case 57. This man, from Sweden, is living, aged forty-two years. His is the tubercular form of the disease. It is said to have first made its appearance in 1888, six years after his landing in America. He is comfortable, in his own home on a farm, well cared for by his wife. He has four children, all girls. The wife and children show no signs of leprosy. The neighbors seem sensible, and there is no tendency to ostracise the family. He is a fortunate leper.

Dead.

Case 58. This woman, a Norwegian, died at the age of twenty-eight, in 1890. Hers was the anæsthetic form

of the disease. She had been in a leper hospital in Norway, and her relations state that she was discharged, "cured." The disease first appeared in 1874, when she was twelve years old. She came to America in 1887. She died of pneumonia, after one month's illness. She was never known as a leper in the community where she lived in this country. Her home was comfortable, and she was well cared for. She was not married. **Anæsthetic.** **Comfortable.**

Case 59. This woman, from Sweden, died at the age of fifty-five years, but a few days ago. Hers was the mixed type of leprosy. It first appeared as the anæsthetic type, in 1886. She was married and had six children, two of whom (girls) are still living, as is also the husband. None of these show any symptoms of leprosy. If there was a chance for infection it would seem as though it might have occurred in this family, for the woman was filthy in her habits. Fortunately her husband and children had a dread of the disease, and this served as a safeguard. Even in this favored state I would not have been willing to have taken a chance against contracting this disease while living in this woman's home. A leprosarium was the place for this patient, but she is beyond its benefits now. **Dead.** **Mixed.** **Fourteen years.** **Leprosarium.**

Case 60. This man, a Norwegian, died at the age of thirty-five, in 1898. His was the tubercular form of the disease. It is said to have first appeared in 1888, but this was the year that he came to America. He was married and had one child. His wife was devoted to him, and he could not have had better care than that given him during his last illness. Neither his wife nor child show any signs of leprosy. A leprosarium would have been of no benefit to this leper. **Dead.** **Tubercular.** **Comfortable.**

Case 61. This man, a Norwegian, is still living, aged sixty-seven years. His is the tubercular form of the disease. He is married, and has eight children. Neither his wife nor children show any signs of the disease. He is quite well cared for at home. He has a brother in a leper hospital in Norway. **Living.** **Tubercular.** **Comfortable.**

Case 62. This man, a Norwegian, is still living, aged forty-four years. His is the tubercular form of the disease. It is said to have first made its appearance in 1893, seven years after his coming to America. In 1899 the **Living.** **Tubercular.** **Poor.**

question of returning this patient to Norway was under consideration, but the opportunity was allowed to pass, and he is now blind and helpless—a pauper. A leprosar-
Leprosarium. ium is the place for him. He is now a county charge. He has never been married.

Living. Mixed. *Case* 63. This man, from Sweden, is still living, aged forty-four. His is the mixed form of leprosy. The disease is said to have been first noticed in 1893, eleven years
Poor. after he came to America. He was a laboring man as long as he was able to work, but now is a pauper. He has not been married. His mother, one brother and one
Leprosarium. sister died of leprosy in Sweden. Undoubtedly the place for this man is in a leprosarium.

Living. Anæsthetic. *Case* 64. This man, a Norwegian, is still living, aged fifty-five years. His is the anæsthetic form of the disease, and is quite mild. Probably only his physicians and intimate friends know that he is a leper. The disease is said to have first appeared in 1893, eight years after his having come to America. So far as known his general surround-
Good home. ings are good, and he is comfortable at home. His wife and three children show no symptoms of leprosy.

Living. Mixed. *Case* 65. This man, a Norwegian, is still living, aged about thirty-two. His is the mixed form of the disease. He states that the disease first appeared in 1898 (this is questionable). He has the leonine countenance, but by
Good home. one not a close observer would not be thought of as a leper. He is able to attend to business. His wife and two children, aged six and three years, show no signs of leprosy. He came to America in 1888. His mother and one sister died of leprosy in Norway. He says his condition is improving under "Christian Science" treatment, but appearances when I last saw him did not bear him out.

Dead. Anæsthetic. Twenty-two years. *Case* 66. This man, a Norwegian, died at the age of seventy-three, in 1899. His was the anæsthetic form of the disease. It is said to have appeared twenty-two years before his death, and one year after landing in America
Poor. (not probable). He admitted having had one leprous cousin. He was a pauper for years, and finally died at the
Leprosarium county poor farm. He was not married so far as known.

Dead. Tubercular. *Case* 67. This man, a Norwegian, died at the age of forty-two years, in 1898. His was the tubercular form of

the disease. The disease was first recognized in 1876, when he was twenty years old. He came to America in 1877, but, finding no improvement, he returned to Norway about 1880. I think he was in a leper hospital in Norway. He was self-supporting while in Minnesota. He was single. Self-supporting.

Case 68. This man, a Norwegian, is still living. He has but recently been reported to the Minnesota State Board of Health, and there has not been time to investigate the case. From the description given, this is the tubercular type of the disease. The neighbors are afraid of this man, and shun him as one unclean. Living. Tubercular. Leprosarium.

Case 69. This man, a Norwegian, is still living. His is the tubercular form of the disease. He is a laborer, thirty-one years old, and single. He came to America about seven years ago, and then had leprosy in its early stages. Probably he will become a public charge as he grows worse and becomes unable to work. Living. Tubercular. Poor. Leprosarium.

Case 70. This man, a Norwegian, may possibly be in our records without designation. He was a brother of Case 32, and died in 1895. I can find no facts on file relative to the case. The father of these two cases also died of leprosy, and is probably one of the early cases on our records without a name. (Case A, page 22.) Dead.

Case 71. This man, a Norwegian, came to Minnesota, a leper, about 1890. He was then about twenty years old. His trip here was to see if his condition would not improve in this climate. There being no apparent improvement, he returned to Norway about 1897. His was not a marked case of leprosy. While resident in this country he was self-supporting. It is not known positively that he is dead. Dead.

Case 72. This man, a Norwegian, is still living, at the age of twenty-two. His is the tubercular form of the disease. The symptoms of leprosy are said to have appeared about five years ago, six years after his coming to America. He is single and destitute and cared for as a public charge, at an annual cost of $650. He lives in a part of the country where the people are unnecessarily alarmed over a leper, and for this reason he has to be given special care. This patient should certainly be in a leprosarium. Living. Tuberculous. Poor. $650.00. Leprosarium.

Living.

Tubercular.

Case 73. This man, a Norwegian, is still living, and a *prisoner* for the remainder of his life, which will probably not be long. His is the tubercular form of the disease. He was born in 1847, and came to America in 1882. His case was first diagnosticated as leprosy in 1893. Soon after this it became known in his neighborhood that he was leprous, and the process of ostracising him and his family began. He lived on a farm, and was prosperous. It became necessary for the county commissioners to separate him from his family, and to place him in a house alone, although on his own place, with another leper, less advanced with the disease, to care for him. The community follow out the Bible injunction to the limit in treating this man and his family as unclean. The house in which he lives is about a quarter of a mile from the house in which his family lives. His wife cooks for him and his attendant, and the food is carried and placed at a safe distance from their prison three times a day. It costs the county in which he lives about $600 per annum to care for him. His wife and six children ranging in age from ten to twenty-two years, although perfectly healthy and entirely separated from the patient, are practically ostracised. When it was found that the children had a legal right to attend school, they and two families related to them were allowed full ownership of the school building, and the school directors set about building another schoolhouse for the rest of the children of the district. I am happy in the fact that this kind of treatment is not as a rule given to lepers or their families in Minnesota.

$600.00.

Leprosarium.

Living.

Tubercular.

Poor.

$600.00.

Leprosarium.

Case 74. This man, from Sweden, is the keeper of Case 73. He has the tubercular form of the disease. He is poor, is single, and will be a charge upon the county so long as he lives, unless there is some other provision made, state or national, for the care of lepers. His cost is estimated at $600 per annum. He has been resident in the state four years, and has been in the United States seven years. He admits having noticed swelling of the face in 1897.

Not leprosy.

Case 74 A. This case is interesting because *not* leprous. He was reported to me as an American-born leper. Investigation revealed the following: A child, fourteen years old, was born in the state where he now resides,

of healthy Norwegian parents. He has eight brothers and sisters living, all healthy. When about one year old he had "cholera morbus," but no physician was in attendance. He apparently recovered from this, and learned to walk a little, but later the gait became irregular, and the power of walking was lost entirely in 1890. Paralysis of the lower extremities became complete. At present the chest, shoulders, head, etc., are well developed, but the lower extremities are small. The thighs are flexed on abdomen and to the left, so that, as the child lies on his back, his knees rest on the bed at his left side. The skin is very fair. The boy seems bright, and has a good face. The parents try to take good care of him, but are not as cleanly as they should be. Where the body comes in contact with the bed there is a line of dirt upon the skin and a scaly eruption—a filth eczema. There are eruptions on various parts of the body, due to contact of a sensitive skin with soiled bedding, or to bites. There are also bed sores. It was worth the hard drive that I made of about one hundred miles one Sunday to see this case to be able to say *not leprous*, and that I had yet to learn of the first American-born leper in this section of the country.

Case 75. This woman's history, and the fact that she was well cared for during her latter days, is set forth in the records of the Johns Hopkins Hospital. The necessity for leprosaria is well demonstrated by the treatment this patient would have received but for the hospital already named. She was an American who contracted the disease (tubercular form) in the West Indies. She died in 1900. She was a public charge for three years. No children living. **Dead.** **Leprosarium.** **Tubercular.** **Poor.**

Case 76. This woman, an American, has been a leper for forty years. She is now seventy-eight years old. Hers was at first of the anæsthetic form, but is becoming more and more tubercular in character. She has been a public charge for eight years, at a cost of $1,000 per annum. She would be a proper case for a well organized leprosarium. I do not know whether she has had children. **Living.** **Anæsthetic and tubercular.** **Forty years.** **$1,000.00.** **Leprosarium.**

Case 77. This man, from Sweden, died at the age of forty years, this year (1900.) His was of the mixed type of the disease. It first appeared in 1888. He was a public **Dead.** **Mixed.** **Twelve years.** **Poor.**

Leprosarium. charge for ten years before his death. He was never married.

Dead. Eighteen years. Mixed. Leprosarium. $1,200.00. *Case* 78. This man, an American, contracted the disease in Brazil, and died at the age of forty-four years this year (1900.) He returned to Pittsburg in 1879, and the disease has a history dating from 1882. His was the mixed form of the disease. He was a public charge for four years prior to his death, at a cost of $1,200 per annum. He was married, but none of his relatives are leprous.

Dead. Leprosarium *Case* 79. A Chinaman died in 1897. He had been a public charge for seven years.

Dead. Leprosarium. *Case* 80. A Chinaman died in ——. His was tubercular leprosy. He was a public charge for several years.

Dead. Poor. Leprosarium. *Case* 81. A Chinese laundryman was found to be leprous. He was placed in a county hospital, where he died eventually.

Case 82. Of this case I have no data.

THE UNOFFICIAL LIST OF LEPERS.

Living. Tubercular. *Case* 1. This man, a Mexican, was recognized as a leper. He was self-supporting, and when people became suspicious as to the nature of his disease he disappeared. His was the tubercular form of the disease.

Dead. Leprosarium. *Case* 2. An American physician, who had been a good deal of a traveler, contracted the disease abroad, and died in this country in a hospital. The final illness was of short duration.

Living. Leprosarium. *Case* 3. A Chinaman, discovered to be leprous, was advised to move on. He did so. It is stated that he wanted to return to China, and he was given means to do so. It is not known whether he followed his inclination in this matter or not.

Leprosarium. *Case* 4. A Greek; when found to be leprous, he returned to his own country.

Case 5. A typically leprous Norwegian woman. When she learned that she was to be examined for leprosy she disappeared.

Leprosarium. *Case* 6. A Norwegian is spoken of as returning to his native country in 1891 to enter a leper hospital.

Case 7. A Norwegian resident who is classed among the "cured" lepers. His name and residence are known only by his physician, who is pledged to secrecy. Living.

Case 8. A Norwegian, who lived in a district where lepers were shunned with a vengeance. When his disease was recognized, he was supplied with money and sent, with his family, to Norway. The house in which he lived (not an expensive one, I presume), was bought by the neighbors and burned to the ground. Leprosarium.

Cases 9 *to* 21, *inclusive*. These are all Icelanders. None of them are known to be leprous in the communities where they live. None of them are American born. In some the disease is said to be "arrested." Leprosarium

Case 22. This was a Chinaman in a neighborhood where there had already been a great deal of trouble over leprosy. When his condition was recognized he disappeared from the locality, but probably not from the state. Dead. (See Case E, page 23.)

Case 23. This is a Norwegian woman, whose name ought to be in the official list of one of the states, but is not. She is probably dead, for in 1889 she is described as being fifty-eight years old, and affected with tubercular leprosy. Tubercular. Leprosarium. Living.

Case 24. This man, a Norwegian, ought to be upon the official list, but his name was secured Oct. 15th, a date too late to allow of further investigation. Dead. Mixed.

Case 25. This man, a Norwegian, had the mixed form of leprosy. He died about 1888. He was kept in a private house, having certain rooms given up to him exclusively. He was a single man. Not a public charge. Leprosarium. Comfortable.

SPECIAL CLASS.

Dead.

Case A. This man, a Norwegian, was one of the early lepers in Minnesota, and died many years ago. There is no positive record of this case, but it is probable that he represents one of the three first in the Minnesota list (Case 10, 11 or 12). He came from a leprous district in Norway. Two of his sons died in Minnesota of leprosy (Cases 32 and 70). Dead.

Case B. This man, a Norwegian, died of leprosy about 1884. None of the records on file are known positively to refer to him, but in this, as in the preceding case, it is

probable that he represents one of the first three in the Minnesota list (Case 10, 11 or 12). Quite recently I was asked to investigate the descendants of this man, for some of them were suspected as being leprous; but the suspicion was groundless. He has children and grandchildren living, none of whom show any signs of leprosy. Tuberculosis has brought death to many of his descendants, and the conditions of some of these tuberculous patients had suggested to the suspicious the possibility of leprosy.

Cases C and D. Nothing is known of these cases further than that they came from Canada, and were about to settle in northern Minnesota when they learned that they were to be examined as to their being lepers. Thereupon they returned to Canada. It is quite possible that these were Icelanders, for there are many such in Manitoba, and leprosy is not an uncommon disease among them.

Case E. A Chinaman presented himself to a physician for an opinion as to whether he was leprous or not. He stated that an opinion had been given in the affirmative. He was requested to call at the physician's office for an examination, but never did so. As this occurred in the state where Case 22 was given money and told to clear out, it is quite possible that the two are one and the same.

STATISTICS FROM OTHER PARTS OF THE UNITED STATES.

Leprosy statistics from others parts of the United States may be of interest at this point. Dr. Morrow, in his article in the "Twentieth Century Practice of Medicine," Vol. XVIII, (1899), reports as follows:

For California, a total of 196, at present 26; South Carolina, a total of 16; Texas, a total of 34; Louisiana, a total of 277, at present 131.

Dr. Hyde, to the Congress of American Physicians and Surgeons (1894), reported for other states the total as follows:

Arkansas, 3; Dakota, 2; Florida, 6; Georgia, 1; Idaho, 1; Illinois, 13; Indiana, 2; Iowa, 20; Maryland, 4; Massachusetts, 5; Minnesota, 120; Missouri, 2; Mississippi, 2; New York, 100; New Jersey, 1; Oregon, 3; Pennsylvania, 6; Utah, 3; Wisconsin, 20.

My own records for certain states compared with Dr. Hyde's are as follows:

	Dr. Hyde.	Present Paper.
North Dakota	2	2
South Dakota	...	1
Iowa	20	3
Minnesota	120	61
New Jersey	1	1
Ohio	...	1
Pennsylvania	6	6
Wisconsin	20	7

I presume Dr. Hyde's figures for Iowa and Wisconsin are estimated. Probably they are not too high. I have taken only those cases of which a history could be given. It is probable that the 120 cases credited to Minnesota are taken from Dr. Hansen's report. It seems to me this, too, must be an estimate. Dr. G. Gronvold was in close touch with Dr. Hansen when he visited Minnesota. If there were 120 cases in the state, I cannot understand why they are not on our records. If there were that many cases in 1888, the number for Minnesota is much higher than I have given, for many of the cases in our official list cannot have possibly belonged to Dr. Hansen's 120.

Dr. Morrow's article (already referred to) states that the Tracadie (New Brunswick) lazaretto has admitted altogether 150 lepers, and

that in 1899 there were still twenty-three inmates. He also assigns eleven as a total for Cape Breton and ten for British Columbia.

Mexico has her proportion of lepers.

It might appear from the report of cases in the Northwest that leprosy was far more common in Minnesota than in the neighboring states. I can see no reason for this belief, however, for the lepers in this district are among the immigrants from Norway, Sweden, Iceland and China. These people have quite a representation in all this group of states. I can only attribute the more complete returns for Minnesota to the fact (1) that there has been less agitation against leprosy in this than in some of the neighboring states; (2) that with this lack of agitation against leprosy physicians report their cases more willingly to the state board of health, which has endeavored during the last twenty years to palliate the sufferings of this unfortunate class; (3) that Minnesota is fortunate in having among its physicians men who are familiar with leprosy, and who are interested in philanthropic work, and these physicians have given material aid to the state authorities engaged in securing a list of all lepers in Minnesota. It may be worthy of note that several lepers in the Minnesota list give the history of a previous residence in Wisconsin, but their names in not a single instance appear upon the Wisconsin records. It might seem to some that, in discussing the leprosy question, it was only necessary to consider those cases now living; but if we are to judge of future needs we must know conditions of the past as well as of the present. Of the thirty-seven living lepers known to be resident in the Northwest, permit me to state that seventeen only are in Minnesota, and there is a strong possibility of two of these being dead, but we have no positive knowledge of the fact.

It does not seem that all parts of the country are favored as are Minnesota and adjoining states, where not a single American-born leper is to be found, even among the descendants from a leprous parent.

I do not dwell upon these facts as an alarmist, but simply to remind you that leprosy has existed, does exist, and will continue to exist for years to come in all three countries represented in this association.

Were we to look only at the disease and its future it might be dismissed without further consideration by the group of Northwestern States especially referred to in this report. But we must admit that imported cases will continue to appear, even here, and

humanity demands that such should be cared for rather than to allow them to drag through years of suffering.

With this presentation of facts I think all will admit the need of leprosaria, and most of you, I doubt not, will feel that the nation is better fitted than any one state to establish and maintain them. It is impossible for a single state, even though it may have a considerable number of lepers, to provide for them at a reasonable rate or to make them comfortable. Louisiana is the only state that has tried to establish a leper colony. In many states lepers are cared for as paupers, but they cannot be allowed to associate with other paupers; hence, they are cared for in "isolation wards," which are, as a rule, veritable prisons, and often a hell on earth.

The uninfected have an inherited dread of leprosy. They do not appreciate that tuberculosis, syphilis and many other preventible diseases are far more dangerous than is leprosy. Hence comes the unreasonable persecution of the leper. If a laborer, he is no longer able to secure employment. If an individual living in comparative comfort, the cry goes out through his neighborhood, "Unclean! Unclean!" and in consequence his neighbors shun, not only the leper himself, but all those who are associated with him. His family is ostracised. His children are either excluded from school or their surroundings are made so uncomfortable that they by choice prefer to stay away. I have seen a family, with children ranging in age from ten to twenty-two years, which was practically shut out from the world because, forsooth, the father was a leper. He did not live with the family, nor have any intercourse with it, and yet the ostracism was complete against all its members.

With a husband depending upon his work at a trade to support his family, and who could not get employment because of his wife's illness; with children approaching school age, who were practically shut out of school on account of the mother's condition, I have seen a poor woman pray for death to come and release her and them; and yet she lived for years under just such suffering.

I have knowledge of a single man, by no means a source of danger, who was driven out of the community in which he lived. He had means sufficient to supply his wants. The people with whom he lived knew how to care for him properly, and were willing to do so. He was blind, yet public sentiment drove him away, and made him homeless. A state refused to allow him to travel through it by rail, and a car containing this unfortunate man was sidetracked. It is hard to imagine what might have become of him had not a good Samaritan, a physician, gone after him, and driven with him a

hundred miles or more across country to his own home, where he kept him until he was able to find a safe and somewhat permanent retreat for him. Truly a leprosarium of the right kind would be a blessing to all lepers subjected to such indignities. It is not only the leper who is financially poor who demands our thoughtful care.

I have seen leper colonies that were nothing but places of abode for the living dead. Far be it from me to urge the establishment of such places in our country. Let us consider briefly what we should find in a leprosarium, and then decide whether we are to work for the establishment of our ideals.

A leprosarium should afford a comfortable home for lepers. This means, not only good buildings, but extensive grounds comprising many acres, where the lepers may have liberties and still be in exclusion. The buildings connected with the leprosarium must combine the privileges of a home and of a hospital. Those who have the disease in mild form may need little if any medical care. They need comfortable clothing and good food. With those in whom the disease is more advanced, the care should be that of a hospital patient, with medicines to lessen their sufferings and dressings that would commend themselves to any surgeon.

A leprosarium should resemble our modern colonies for epileptics. It should furnish employment for those who are able to work, and amusement of various kinds for all.

The patients ordinarily found in hospitals stay in them for possibly a few weeks, and then return to home and friends. Not so with the leper. He is an outcast,—a patient for life,—but not necessarily confined to bed except for brief periods.

In establishing leprosaria we must give some thought to the lepers and their disease. It would not be humane to transport those who by inheritance and birth belong in a tropical climate to a leprosarium in Minnesota, while on the other hand people of Scandinavian or Icelandic origin should not be sent to Louisiana or the Hawaiian Islands. It would seem, therefore, that at least two leprosaria were needed in the United States. The time is ripe for taking hold of this matter. The committee of which I as chairman present this paper was created by this association two years ago because the need of such humane action was recognized as a necessity. The replies to the circular letter which I sent out, tabulated on page two of this paper, seem to show that sanitarians generally recognize both the need of leprosaria and the fact that they should be national rather than state institutions. California

has already memorialized congress in favor of the national care of lepers. Louisiana, I doubt not, would be glad to transfer her lepers from their present place of abode to a national leprosarium such as I have presented in outline.

Two of the strongest medical societies in Minnesota have placed themselves on record as favoring the establishment of national leprosaria. The American Dermatological Association has a committee appointed, to determine, if possible, the best methods to be used in the care of lepers. It would seem that this association should be ready to place itself on record as anxious to find some solution for this vexed proposition. One thing is certain: we will have lepers in this country for years to come, whether imported or of our own production. The thing for us to do is to recognize the fact, and meet it. The questions involved are those of sanitation and humanity. Sanitarians are, as a rule, humanitarians, and, as we are a recognized body of sanitarians, it is time to act. I, therefore, in closing this paper, propose the following resolutions:

WHEREAS, It is a known fact that lepers are found in Canada, the United States and Mexico; that these lepers represent immigrants of many nationalities, together with some Americans; that the exclusion of leprous immigrants by inspection is impossible; that the tendency to importation of leprous immigrants in the future will be greater even than in the past; that the danger of infection of American residents abroad and the importation of the disease through these channels is greatly increased; therefor be it

Resolved, That this Association place itself on record as favorable to the establishment of national leprosaria, which may serve, not only as a refuge for lepers, but also as homes and hospitals making their lives tolerable so far as possible, furnishing employment to those who are able to work, and giving skilled medical care to all cases, with the intent of possibly curing some, and making the road to death less wearisome and painful than it now is to others.

SCHOOL INSPECTION.

The question of school inspection for the purpose of excluding infectious disease was discussed at the meeting of this board Jan. 10, 1899. Since this date such inspection has been temporarily adopted at various points when threatened with an epidemic. At the meeting of the board, July 11, 1899, the following, as bearing upon this question, was adopted:

In view of the fact that infectious diseases are more prevalent during the winter than summer; that the schools are the frequent source of infection; that it is to the interests of the schools, as well as the public at large, to exclude infectious diseases so far as possible from the schoolroom; therefore be it

Resolved, That the Minnesota state board of health make a special effort to secure the aid of all teachers in detecting and excluding children suffer-

ing from infectious diseases from the schools; that the board express itself as willing to give instructions, by lectures or otherwise, to teachers, at summer schools, normal schools, or other places where teachers meet together, in the methods of recognizing infectious diseases in their early stages, thus aiding them in becoming active sanitarians.

At the meeting of the board, April 10, 1900, the following action was taken relative to school inspection:

The state board of health, recognizing that there is always a marked increase in the number of cases of infectious diseases upon the opening of schools in the fall; that the transmission of disease from one pupil to another is a common cause of this increase; that it is possible, through school teachers and other school authorities, to discover the presence of an infectious disease during its early stages; that the prompt discovery of an infectious disease, with temporary exclusion from school of the patient, will do much to prevent demoralization of schools, as well as the great expenditure of life and property, would recommend that all school boards in cities and villages throughout the state be impressed with the necessity of employing a medical inspector to carry out the following suggestions:

First—To visit the schools within his jurisdiction daily, in order that he may examine any teacher or pupil complaining or appearing ill, or showing any suspicious rash or symptoms.

Second—To receive information from principal or teachers of absentees, and to satisfy himself as to whether the absence of such teacher or pupil is due to any illness of an infectious nature.

Third—To exclude from schools teachers or pupils suffering from an infectious disease, such as diphtheria, scarlet fever, measles, smallpox, chickenpox, whooping cough and other contagious and infectious diseases, until all source of danger from infection has disappeared.

Fourth—To exclude teachers or pupils living in close association with those ill with any of the above diseases until all danger of carrying infection has been removed.

Fifth—To exclude from school any one suffering with any parasitic disease, such as scabies, pediculi, tinæ, etc.

Sixth—To exclude from school all persons suffering from pulmonary tuberculosis.

Seventh—To make such reports to the secretary of the state board of health, to the local health officer and to the school board employing him as may be required, upon blanks and forms furnished him.

A medical inspector should be chosen and paid by the school board. He should work in harmony with the local and state sanitary authorities. He should in no way interfere with the family physician. He should be faithful and conscientious in his work.

The board again urges the necessity for thorough vaccination. It is worthy of note that, with smallpox appearing in a place, the condition of the school children as to vaccination will largely determine whether schools shall be closed or not.

At various times I have presented to residents of Minneapolis the importance of school inspection, and in October, 1900, was given a hearing by the Minneapolis School Board. At that time a committee, of which Dr. R. O. Beard was chairman, was able to announce that free medical inspection of schools could be secured for the school year of 1899-90, provided the school board would

accept such. (This proposition has been accepted and the volunteer corps of physicians is now under process of organization. Dec. 13, 1900.) The action of this board under date of July, 1899, and April 10, 1900, was sent to school superintendents and principals quite generally throughout the state, but advantage of the offer has not as yet been taken by any school or body of teachers. The recommendation of the board for school inspection has not yet been adopted, so far as I am aware, in a single city or village. Had it been, the number of cases of scarlet fever and diphtheria might have been materially smaller, and the number of closed schools, because of the presence of one or the other of these diseases, might also have been reduced.

PROPOSED NATIONAL PARK IN MINNESOTA.

In 1898 General Andrews wrote this board, asking that we should take an interest in securing the setting aside of some of the region about Cass lake as a health resort. At the last session of the state legislature we joined with the legislative committee of the state medical societies and the federation of women's clubs, asking the federal government to withdraw from the market for the time being the timber in the Leech lake reservation that was about to be offered for sale. The request was granted. In August, 1899, through the instrumentality of Col. J. S. Cooper of Chicago, the Minnesota National Park and Forest Reserve Association was organized. In the fall of 1899 a body of United States representatives visited Cass lake with the purpose of becoming more familiar with our request that this district be set aside as a national park. The Federation of Women's Clubs has given this question a great deal of attention of late. It would seem that there should be little trouble in securing the setting aside of this comparatively small tract as a national park when the state of New York has spent such a vast amount of money in securing a state park. It would seem wise to establish a place for recreation in order to make less necessary the establishment of state sanatoria for the tuberculous. It is better to try to keep good health than to be compelled, after having lost one's health, to spend much money to regain it. We of the Northwest need some rest, and the country about Cass lake is an ideal place for securing such. It is not only the people of Minnesota that would be benefited by such a reserve. Residents from Chicago, from St. Louis, from all parts of the country, in fact, would flock to such a place for rest and amusement,

as they now do to the Adirondacks, to the White mountains, etc. Such a reserve would not only be of great benefit to our state as a health resort; it would also be of great financial advantage. But selfish interests are at work to thwart the efforts of the philanthropists. The lumbermen, who care nothing for the forests further than to convert them into dollars, and whose interests lead them to seek the almighty dollar rather than the preservation of human life, are pressing hard upon Congress to throw this natural paradise open, and allow its conversion into a veritable place of desolation.

SEWAGE DISPOSAL.

The question of sewage disposal is one of vital importance in the state. As villages grow municipal or private water systems are put in, and following this the construction of houses with "modern improvements," which necessitate a sewerage system. In considering sewage disposal it is the rule with villages to make the discharge into the nearest body of water. It is not an uncommon thing to find sewage discharged into small lakes or shallow streams that do not flow during the summer season. This is not only a dangerous and filthy proceeding, judged from a sanitary point of view, but it is illegal. There is a special law against the pollution of streams, etc., which reads as follows:

AN ACT TO PREVENT THE POLLUTION OF RIVERS AND SOURCES OF WATER SUPPLY.—CHAPTER 225, LAWS OF 1885.

Be it Enacted by the Legislature of the State of Minnesota.

SECTION 1. No sewage, drainage or refuse or polluting matter of such kind as either by itself or in connection with other matter will corrupt or impair the quality of the water of any spring, well, pond, lake, stream or river for domestic use, or render it injurious to health, and no human or animal excrement shall be placed in or discharged into, or placed or deposited upon the ice of any pond, lake, stream or river, used as a source of water supply by any town, village or city; nor shall any such sewage, drainage, refuse, or polluting matter or excrement be placed upon the banks of any such pond, lake, stream or river, within five miles above the point where such supply is taken, or into any feeders or the banks thereof, of any such pond, lake, stream or river.

SEC. 2. The state board of health shall have the general supervision of all springs, wells, ponds, lakes, streams or rivers used by any town, village or city as a source of water supply, with reference to the purity, together with the waters feeding the same, and shall examine the same from time to time, and inquire what, if any, pollution exist, and their causes. In case of a violation of any of the provisions of section one (1) of this act, said board may appoint a time and place for hearing parties to be affected, and shall give due notice thereof, as hereinafter provided, to such parties, and after

such hearing, if in its judgment the public health requires it, may order any person or corporation, or municipal corporation to desist from the acts causing such pollution, and may direct any such person or corporation to remedy the pollution, or to cleanse or purify the polluting substance, in such a manner and to such a degree as shall be directed by said board, before being cast or allowed to flow into the waters thereby polluted, or placed or deposited upon the ice or banks of any of the bodies of water in the first section of this act mentioned. Upon the application of the proper officers of any town, village or city, or of not less than legal voters of any such town, village or city, to said state board, alleging the pollution of the water supply of any such town, village or city, by the violation of any of the provisions of this act, said state board shall investigate the alleged pollution, and shall appoint a time and place, when and where it will hear and examine the matter, and shall give notice of such hearing and examination to the complainant, and also to the person or corporation, or municipal corporation alleged to have caused such pollution, and such notice shall be served not less than ten (10) days prior to the time so appointed, and shall be served in the same manner that now is, or hereafter may, be by law provided for the service of a summons in a civil action in the district court. Said board, if in its judgment, any of the provisions of this act have been violated, shall issue the order or orders already mentioned in this section.

Sec. 3. The district court, or the judge thereof, may upon the complaint of said state board, or of the proper authorities of any town, city or village whose sources of water supply shall be so polluted, issue an injunction to enforce the orders of said state board.

Sec. 4. Such orders of the state board shall be served upon the persons, corporations, or municipal corporations found to have violated any of the provisions of this act, and any party aggrieved thereby, shall have the right to appeal to the district court of the county in which is situate the town, village or city whose source of water supply is found to have been polluted, and such aggrieved party shall have the right to a trial by jury in the same manner as in a civil action in said court. During the pendency of the appeal, the pollution against which the order has issued, shall not be continued contrary to the order of the state board, and upon the violation of the order the appeal shall forthwith be dismissed.

Sec. 5. Any person, corporation or municipal corporation desiring to appeal from any such order of the state board, shall, within thirty (30) days after the service upon him or it of a copy of such order, file in the office of the clerk of the district court of the proper county, a notice of such appeal, together with a bond in the sum of not less than two thousand (2,000) dollars, with two (2) sureties, to be approved by the judge of said court, conditioned for the prosecution of such appeal to judgment, and for the payment of all the costs and disbursements that may be adjudged against him or it therein, and shall, within three (3) days after such filing, serve a copy of such notice and bond upon the secretary of said board; and said secretary shall, within ten (10) days thereafter, deliver such copies so served upon him to the mayor or other chief executive officer of any such city, village or town, whose source of water supply has been found to have been so polluted.

Sec. 6. Water boards, water commissioners, water companies, and the proper officers of any city, village or town, making use as a source of water supply, of any well, spring, pond, lake, stream, river, reservoir, or well, within, or partly within, this state, and distributing the waters thereof for public, domestic and general uses, shall, from time to time, and whenever required by said state board, make returns to said board, upon blanks to be furnished by it, of such matters as may be required by said board and called for by such blanks, and any such water board, water commissioners, water company, or officers of any city, village or town, who shall, for the space of thirty (30) days after being furnished with such blanks, fail or neglect to make any such report so required, shall, for each and every such neglect or failure, forfeit and pay the sum of one hundred (100) dollars, for the use of the

local board of health, or the proper officers acting as such, of the city, town or village where such delinquent has its principal office. Said state board shall, in the name of the state, prosecute in the district court of the proper county an action for the recovery of the penalty or forfeit herein imposed.

SEC. 7. This act shall take effect and be in force from and after its passage.

Approved March 7, 1885.

It will be well for villages and cities to keep this law in mind in the future when they are making plans for sewage disposal. It may cost a trifle more at the outset to do things as they should be done, but such action will be economical in the long run. It is practical to filter sewage, and this should always be insisted upon before it is discharged into stream, lake or pond. Sewage filtration is now quite extensively in operation in the more advanced sanitary districts of our own country.

WATER SUPPLIES.

Associated with the problem of proper sewage disposal is that of a good water supply. The ordinary village well is a menace to health and a public nuisance. Many of these wells are but a few feet deep, and the water found in them is not only from the surface, but is the drainage from the backyard, from stables or sheds near by and from privy vaults. It would seem that anyone with ordinary reasoning power could realize the dangers present in drinking water taken from a source with such filthy surroundings. And yet apparently intelligent people will boast of their water supply because of its good flavor and clear quality when a chemical examination will demonstrate that it is highly contaminated with organic matter. With surface drainage supplying a family or community with drinking water, it is only a question of time as to when typhoid fever will make its appearance, for this disease is, in the great majority of cases, conveyed by water supplies, directly or indirectly. To bear out this statement, you are referred to the typhoid fever record, page 71.

The chemical survey carried on by this board during the past two years in the southern part of the state, and described fully by the chemist, Mr. H. C. Carel, further on in this report, shows very conclusively that there should be more attention given to water and ice supplies as well as to sewage disposal.

ICE SUPPLIES.

Closely associated with the question of drinking water supplies and sewage disposal is that of ice supplies. It is a common belief that freezing destroys all sources of infection, and renders water that may be highly contaminated with organic matter or germs perfectly safe. There is nothing that can be more misleading than such a statement. Typhoid fever and many other intestinal diseases may be traceable directly to infection from an impure ice supply. Ordinary freezing does not destroy disease germs present in water. It is no uncommon thing to see ice cut for domestic use from places that must be contaminated, and with the evidence so apparent that the most casual observer might so testify. This should not be. The choice of place for securing ice for domestic use should be most carefully made. A chemical analysis of the water at the point chosen should also be made before any ice is collected.

Our board, at its meeting July 10, 1900, indorsed the following recommendations, as suitable for adoption by local boards of health or by village or city councils to protect their ice supplies:

RELATING TO ICE COLLECTIONS.

No ice shall be cut or taken from any lake, pond, pool or stream for use in any city or village by any person except by permission of the local or state board of health.

Any person desiring to cut, take or remove ice from any lake, pond, pool or stream within any city or village, or from any source outside of any city or village, if said ice is to be used within the limits of any city or village, shall first obtain from the local or state board of health permission in writing, signed by the chairman and secretary of the board. The permit issued by said board shall in each instance specify the limits within which ice may be cut, taken or removed, and no permit shall be issued or be in force for a period longer than one year.

No person shall bring into or have in his possession within the limits of any city or village any ice cut or removed from any lake, pond, pool or stream, or any portion thereof, by any person who has failed to first take out a permit for such cutting and removal, or by any person whose permit has expired.

Any person who fails to take out a permit before cutting or removing any ice from any lake, pond, pool or stream within any city or village, or from any lake, pond, pool or stream outside of the limits thereof, where the ice is to be or is brought within the limits of any city or village, shall be liable to a fine of not less than ten (10) nor more than twenty-five (25) dollars for each offense.

No person, officer or board within any city or village, except the local board of health or its proper officers. or except the state board of health or

its proper officers, and as its regulations provide, shall grant, sign or deliver any permit for taking ice from any such lake, pond, pool or stream.

It shall be the duty of the board of health of any city or village to enter complaint before the proper court against every person violating any of the provisions of this regulation, and upon conviction thereof, the offender shall be fined in a sum not less than ten (10) nor more than twenty-five (25) dollars for each offense.

H. M. BRACKEN, M. D.
July 10, 1900. *Secretary and Executive Officer.*

CREAMERY WASTE.

It is a common custom to locate a creamery without any reference to the disposal of its waste. Very often this is discharged through an open drain, upon low ground. The stench from this decomposing mass can only be realized by those who are subject to its annoyance. It is like that of decaying animal matter. It is no uncommon thing to find the creamery refuse decaying in some low-lying village lot, with residences close at hand on all sides. If the local board of health is appealed to to suppress the nuisance, it too often happens that no attention is given to such, because those owning or operating the creamery are people of influence in the village, and the members of the local board are afraid of bringing upon themselves the ill-will of such people. I have known of cases when, in answer to the complaint of citizens, the creamery officials have replied that if they were put to any expense in disposing of their waste they would move the creamery to some other place,—a threat that too often is followed by the continuance of the nuisance, because of intimidation of the complaining parties. It is possible for a creamery to dispose of its waste without creating a public nuisance. If it fails to do so, the local health authorities should see that the nuisance is abated. If the local health authorities neglect their duty, it is possible for any citizen to take steps to abate a nuisance by injunction.

FACTORY WASTE.

The discharge of factory waste into streams has not yet become a general nuisance in Minnesota, as it has in many Eastern States. However, complaint has recently been made relative to the discharge of waste from starch factories into small streams. The proprietor of one of these factories, when advised that he must take steps to prevent such nuisance, maintained that there was nothing offensive in this refuse, and justified his action

by claiming that the custom of discharging such refuse was quite general in Maine. The Maine health officials admit that there is much truth in his statement, but further state that such actions are recognized as public nuisances, and that steps will be taken to free their state from this cause of stream pollution as soon as possible. It is easier to prevent the establishing of an evil than it is to suppress it after it has gained a firm footing. It is better that our laws relating to the pollution of streams should be observed by the proprietors of starch factories than that we should allow a custom of law breaking to secure such a firm footing as to make it difficult to break it up later. Regarding the refuse from the starch factory referred to above, where the proprietor claimed there was no reason for complaint, an inspector whom I sent to examine into the actual conditions reported as follows:

H. M. Bracken, M. D., Secretary State Board of Health,

Dear Sir: With reference to the complaint of pollution of Goose creek by starch factory at Harris, Minn.:

I visited Harris May 31st. Saw Messrs. ——— and ———, complainants. Examined the creek immediately above and at several points below the factory. The creek is a small stream, from four to ten feet wide. Just below the factory it was quite free from any refuse, due, as I was told, to the fact that the owner of the factory had had the creek cleaned out for a third of a mile from the factory. At points which I examined about one, two and three miles below the factory, the potato gratings and refuse lie in great masses in all still places and where there is anything to obstruct its free passage. This substance seemed to cover the whole bottom of the creek, and at some places seemed three or four feet deep. This refuse had a very decided odor, and must be very disagreeable at times. I was told that cattle became sick after drinking the water, and that several died. Two horses belonging to Mr. ———, it is claimed, have died from drinking the water. Within a few days after the factory commenced operating this spring all the fish died. I saw no evidence of dead or live fish, but was told that near the mouth hundreds of dead fish were lying on the banks.

Unless the creek is dredged out it seems to me that it would require some time for the conditions to improve, as the stream is in places literally filled with the potato gratings and yeasty masses, which, Mr. H. said, even the high waters in the spring did not entirely dislodge.

Above the factory the stream is quite free from rubbish, and the water very clear.

The factory closed May 15th. It is due to start up again October 1st.

The factory is in the village of Harris. The complainants are farmers living on the creek in the township of Sunrise, Chisago county.

Respectfully,

———————

St. Paul, Minn., June 1, 1900.

THE DISPOSAL OF GARBAGE.

The question of garbage disposal has been forced upon this board by the attitude of Minneapolis to the surrounding country. For a city of its size, Minneapolis presents a most marked example of needed sanitary reform. It had a contract providing for the removal of garbage, but it has provided no place of deposit for, nor does it require any special sanitary precautions in the removal of the same. The contractor has dumped these objectionable products into the neighboring villages of Robbinsdale and Golden Valley. The citizens of both of these villages protested against such action, but their protests were of little avail. It seems to be a case of the weaker party being compelled to yield to the stronger, —a case where might is right. Minneapolis has a very efficient ordinance defining how garbage shall be hauled, and yet all sorts of offensive vehicles and containers are used in the collection and disposal of garbage. The garbage contractor established a dump in the village of Robbinsdale with the result that the village board of health tried to stop the nuisance. This attempt failed. Another attempt through the courts was made, but failed. Then an attempt was made to prevent by injunction a continuance of the nuisance, but here again the Robbinsdale people lost, temporarily at least, for while the judge ruled that there was unquestionably a nuisance, he insisted it must be borne for a time because it had been tolerated already for a period of about eighteen months. (Tolerated because the courts failed to relieve the complainants, the judge should have said.) I imagine had St. Paul been dumping garbage in Minneapolis under similar conditions to those under which Minneapolis dumped garbage in Robbinsdale some means would have been found by which to secure an immediate abatement of an acknowledged nuisance. Had Minneapolis no spare lands within its city limits there might have been some excuse for delaying the abatement of the nuisance, but there are many places where garbage can be as well cared for as at the present Robbinsdale or Golden Valley sites.

This raises the question as to what should be done with city garbage. There are but two answers: Destroy it or utilize it. Garbage has a commercial value. It can undoubtedly be used as food for hogs, if properly handled. Can it be properly handled? Certainly. The style of vehicle or receptacle to be used in hauling garbage over the streets and public highways should be designated by some sanitary authority, and when the garbage has reached its

destination, sanitary rules should define how it is to be kept and fed. A hog pen is quite apt to be a nuisance even where no garbage is fed; hence sanitary rules should designate where such can or cannot be located, especially when garbage is to be fed. It is commonly recognized that people may grow careless when dealing with garbage unless watched closely. There should, therefore, be inspectors to see that the rules regulating the collection and feeding of garbage are observed carefully. Feeding pigs on garbage is cheaper than feeding them on grain. It is not unreasonable, therefore, that those engaged in garbage feeding should pay a license for the privilege. If pens were not located near dwelling houses, churches, schools or other public places, and if the feeding was carried on under sanitary regulation, there could be no reasonable objection to this economical use of garbage.

It has been stated to me that the demand for garbage from Minneapolis is greater than the supply. The garbage has a selling value of five cents a barrel at the dump, or one dollar a load when delivered. There are hotels and restaurants which sell their garbage.

The trend of garbage should always be from the center of the city towards the suburbs.

There are three methods of disposal of garbage,—feeding, burial or burning,—and their relations to each other from an economical point of view are as follows:

For all three methods, the collecting system is practically the same.

If garbage is fed, the expense of handling practically ends with its collection, for the feeders will haul it away without further cost to the city. They may even pay for it.

If the garbage is to be buried, to the expense of collection must be added:

(1) The expense of securing a burial place.

(2) The expense of hauling to the burial place.

(3) The expense of burial.

(4) The value of the food destroyed.

If the garbage is to be burned, to the expense of collecting must be added:

(1) The expense for a site for a crematory.

(2) The expense of erecting a crematory.

(3) The expense of hauling to the crematory.

(4) The expense of fuel required to operate crematory to burn the garbage.

(5) The expense of operating the crematory.

(6) The value of the food destroyed.

(7) The interest on money invested.

(8) The wear and tear on plant.

Any of these methods of disposal will create a nuisance if not properly handled.

A city surrounded by a farming country should have no trouble in disposing of its garbage. Garbage makes good feed, and should be utilized. It is wasteful and expensive to burn it. The only thing necessary is to devise some inoffensive method for handling it. This can easily be done by considering:

(1) The method of collection.

(2) The means of transportation from the city or village,

(3) The method of feeding.

Garbage should be collected from houses in metal tanks or water-tight covered barrels, and these receptacles should be thoroughly cleansed often enough to keep them clean, especially during the hot weather. No leakage should be allowed in collecting, nor along the lines of hauling of garbage.

Garbage should not be fed in the open. When exposed to the sun and weather it rapidly decomposes, and becomes an offensive mass. It should be dumped into receptacles, in shape like an inverted cone, or a deep bin with sloping sides. The bottom of this cone or bin should be perforated, so that the liquid may run off. This liquid should be conveyed into a cesspool or sewer. The bin can be so constructed that hogs may feed from it directly. The feeding should not be done upon the ground, where everything would soon become offensive, but should be upon a water-tight platform, built at least a foot above the ground, so that there would be good exposure to the air on both upper and lower surface. Such a platform may surround the bin containing the garbage. By preference, the garbage bin should be of iron, and should be washed out frequently.

The feeding of garbage should only be permitted where the rules governing such disposal are well observed.

Such disposal of garbage would be in strong contrast to that which has been in vogue in Minneapolis; with its garbage-collecting point in the midst of the business part of the city; with wagons that were movable abominations, dripping their nauseous liquids along the streets and highways; with a system that practically turned neighboring villages into veritable pig ranches, and insisted that quiet, inoffensive people must submit to untold annoyance.

If cities or villages were to adopt an ordinance somewhat like the following, *and enforce it*, there should be no objection to the disposal of garbage by feeding:

DEFINING GARBAGE—DECLARING IT A NUISANCE UNDER SPECIFIED CONDITIONS—SPECIFYING WHO SHALL BE DEEMED TO HAVE CREATED A NUISANCE WITH GARBAGE—AND PROVIDING PENALTIES FOR VIOLATION HEREOF.

The Village Council do ordain as follows:

1. The word "garbage," wherever used in these rules or regulations, is defined to be such refuse of vegetable and animal matter as accumulates in the collection, preparation or use of vegetable or cooked animal matter for human food.

2. Garbage hauled upon any highway in..................unless contained in a water-tight receptacle, with a closed, tight-fitting cover, which receptacle shall have been thoroughly washed out after each day's use, is hereby declared to be a nuisance.

Any person who shall haul any garbage upon any highway in said ...., except in a water-tight receptacle closed with a tight-fitting cover, which receptacle shall have been thoroughly washed out after each day's use, shall be deemed to have created a nuisance.

3. Garbage, or any drippings therefrom, spilled upon any highway in .... is hereby declared to be a nuisance.

Any person who shall spill any garbage, or any drippings therefrom, upon any highway in .... shall be deemed to have created a nuisance.

4. Garbage deposited upon any premises in .... within three hundred (300) feet of any highway, church, schoolhouse or inhabited dwelling, is hereby declared to be a nuisance.

Any person who shall deposit garbage upon any premises in said...... ...., within three hundred (300) feet of any highway, church, schoolhouse or inhabited dwelling, shall be deemed to have created a nuisance.

5. Garbage deposited upon any premises in ...., and not entirely consumed, or buried under at least one foot of dry earth, within twenty-four (24) hours after being so deposited, is hereby declared to be a nuisance.

The owner or occupant of any premises in said ...., upon which garbage shall remain unconsumed or unburied for more than twenty-four (24) hours after being deposited there, shall be deemed to have created a nuisance.

6. Garbage deposited upon any premises in ....for feed, and not kept within water-tight receptacles, with closed, tight-fitting covers, until consumed or buried, except while in process of consumption or burial, is hereby declared to be a nuisance.

The owner or occupant of any premises in said ...., upon which garbage shall be kept (until consumed or buried), in other than water-tight receptacles, with closed, tight-fitting covers, shall be deemed to have created a nuisance.

7. Garbage deposited upon any premises in.....................and not fed in water-tight troughs, built upon water-tight floors or platforms sufficiently large to prevent the garbage from leaking or being scattered upon

the ground, which floors or platforms are under cover, and so built that neither rain or snow can reach the same, is hereby declared to be a nuisance.

The owner or occupant of any premises in said...............upon which garbage is fed, who shall permit it to be fed in other than water-tight troughs, built upon water-tight floors or platforms, sufficiently large to prevent the garbage from leaking or being scattered upon the ground, which floors or platforms shall be under cover, and so built that neither rain or snow can reach the same, shall be deemed to have created a nuisance.

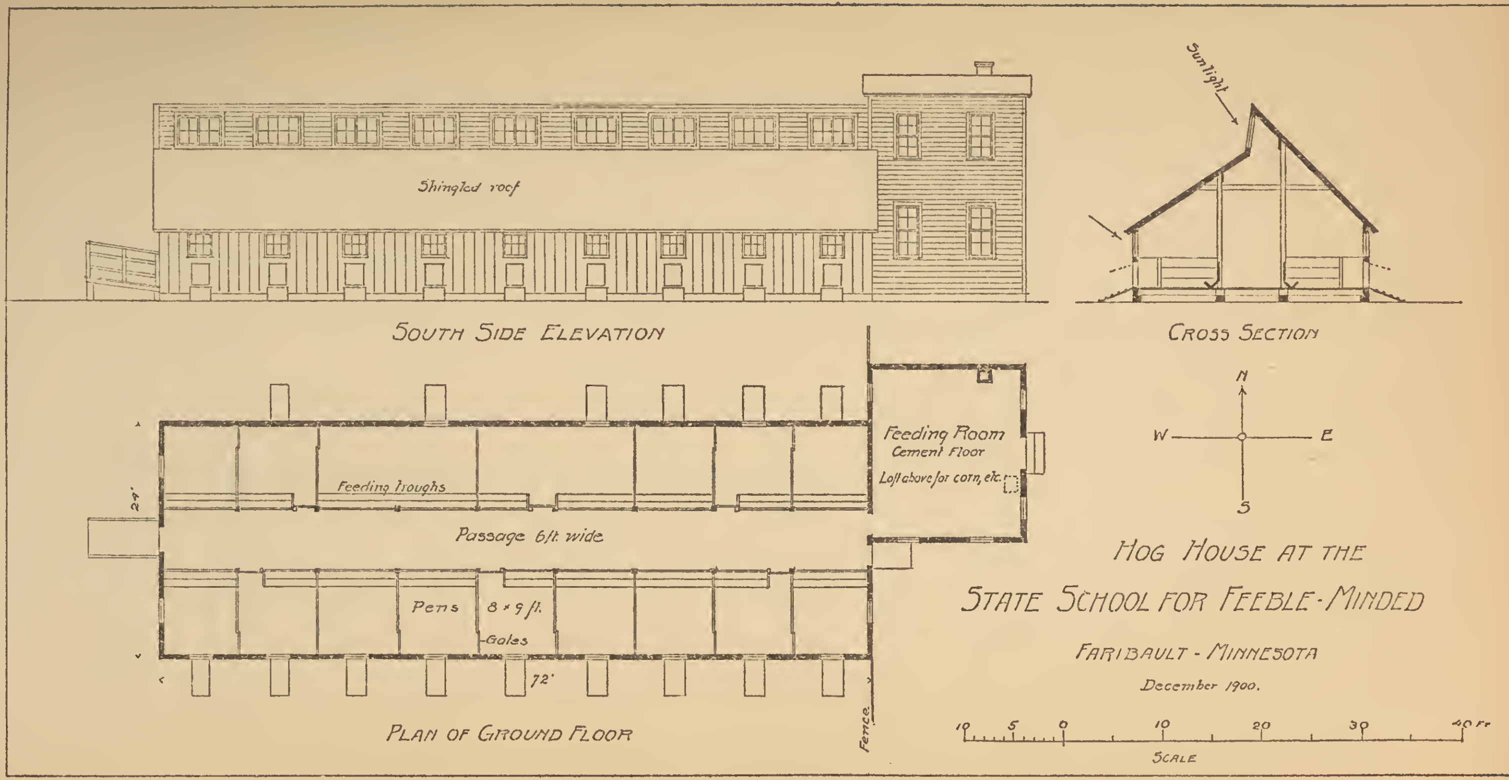
8. Any receptacle in which garbage is kept for feed, upon any premises in ...., and any trough, floor or platform whereat garbage is fed in said village, that is not kept free from offensive odors, and is not thoroughly washed at least once in each week, is hereby declared to be a nuisance.

The owner or occupant of any premises in said..................whereon garbage is fed, who shall not keep free from offensive odors all receptacles on said premises in which garbage is kept, and all troughs, floors and platforms whereat it is fed, and who shall not thoroughly wash at least once a week all such receptacles, troughs, floors and platforms, shall be deemed to have created a nuisance.

9. Any person who shall create a nuisance as the same is defined in any section of these rules and regulations, or who shall permit any such nuisance to exist upon premises in ...., either owned or occupied by him, shall, for the first offense, be punished by a fine of twenty-five dollars ($25) and the costs of suit, and in default of such payment shall be committed to the county jail of..............county for thirty days; and for each subsequent offense he shall be punished by a fine of one hundred dollars ($100) and the costs of suit, and in default of such payment shall be committed to the county jail of .... county for ninety days.

10. These rules and regulations shall take effect and be in force from and after ....

At the school for the feeble-minded at Faribault is a model hog house, constructed under the able supervision of Dr. A. C. Rogers, superintendent of this state institution. Some idea of this building may be gained from the attached diagram. It has a "feeding room," in which all the garbage from the school is received. The garbage is dumped into a large tank and steamed. It is taken from this steaming tank and mixed with bran or other feed in a large iron receptacle. From this room in which the garbage is received and prepared for feeding is a passage-way through the entire length of the house. Two or three planks through the entire length of this passage-way are loose, and can be lifted up when it is necessary to wash out beneath the pens by flushing. This latter can be readily done as the entire building is over a concrete floor which slopes toward the center. The individual pens are on either side of the passage-way, as shown in the diagram, and each is connected with an uncovered yard.



Shingled roof
South Side Elevation
Sunlight
Cross Section
N
W
E
S
Feeding Room
Cement Floor
Loft above for corn, etc.
Feeding troughs
24'
Passage 6 ft. wide
Pens
8 x 9 ft.
Gates
72'
Fence
Plan of Ground Floor
Hog House at the
State School for Feeble-Minded
Faribault - Minnesota
December 1900.
10
5
0
10
20
30
40 Ft
Scale

The cement base for a hog house should be constructed after the following manner: The ground where the house is to stand should be excavated to a depth of eighteen inches. This should then be filled in with sand, and upon this sand should be laid six inches of concrete, consisting of cement, sand and gravel, in proper proportions. Blocks of proper dimensions, upon which to rest the house, should be placed in position in the concrete while it is yet soft. When the mass becomes hard these can be removed, leaving holes in which to rest posts for supporting the house. With such an arrangement there is little chance for mice or rats about the hog pen. At the same time the place is easily kept clean, for should there be any leakage through the plank flooring of the pens it can easily be washed from the cement floor below by raising the loose planks, already referred to, in the passage-way.

The cross section of the house given shows plainly the elevated plank floor, resting upon blocks or other support above the cement floor.

Minneapolis has a "workhouse," and, connected with it, about eighty acres of land. I tried to persuade its board of health to construct such a hog house as I have just described, on the workhouse property. By so doing it would have found a practical means of disposing of a large part of the city's garbage. At the same time it would have given employment to some of the workhouse population, and would have raised at quite a profit a great many hogs. Had the city seen fit to adopt such a plan, it could have demonstrated to the surrounding rural population an ideal piggery, and an ideal and profitable method of feeding garbage.

MEAT INSPECTION.

The need for meat inspection throughout the state has been recognized for some years past, and several attempts have been made to secure the passage of a law requiring such by our state legislature; but all of these, prior to 1899, had a commercial basis, and failed signally. After the failure before the legislature of 1897, I was approached by General M. D. Flower and others interested in packing and slaughtering, who wished to see if a satisfactory bill, based upon sanitary requirements, could not be passed by the legislature. After various consultations, a bill was drawn up and presented to the legislature, but we now found the packing interests against instead of with us—a decided and unexpected surprise. The explanation for this change of base on the part of those who had

previously worked with us in trying to frame a satisfactory bill probably depended upon the following facts:

1. The establishment of a fee system, by which to defray the expenses of inspection.

2. The requirement that all meats to be sold in the state should be inspected.

In defense of the first proposition it may be said that proper inspection, as outlined for the state, would have cost in the neighborhood of $30,000 per annum. We were not disposed to ask such an amount from the legislature. We thought that a small fee for each animal inspected could in no way be unfair, when all packers and butchers were treated alike. The representatives of certain packing houses in the state contended that all packers having federal inspection should be exempt both from state inspection and from the payment of inspection fees. This would certainly have been an injustice to packers not having federal inspection. It would have given the large packers the advantage in the market, as they pay nothing for federal inspection, and, as they themselves stated, the margins for sales are close, it would have been discrimination in their favor.

The claim set up by those packers having federal inspection, that their meats are all inspected by the federal government, and therefore should be exempt from state inspection, is not worthy of further consideration than to state that federal inspection in no way protects the state's interests. It is for the commercial benefit of interstate and export trade. That this is true is evidenced by the two following illustrations: Last summer an agent of one of the large packing houses in one of our larger cities sold condemned sausage to a butcher. Again, Aug. 26, 1899, I received a complaint which reads as follows:

> A case came to my notice to-day. A heifer was run into and knocked down, and so badly injured that recovery was impossible. The railroad company killed the creature, and sold the carcass to ———— Packing Co. here. It had been hurt about twenty-four hours, and must have been in a feverish condition. In other words, the meat was not fit for food. Is it right to pass by such things unnoticed?
>
> (Signed) ————.

Other cases might be cited to prove that all meats sold by packing houses in this state and having federal inspection is not necessarily such as would pass state inspection.

One of the especial conditions demanding meat inspection in this state is the fact that cattle shipped from the west are unloaded,

fed and watered here. At such times animals that will not pass inspection at Chicago or other slaughtering points are "cut out," and, rest assured, these are not sold to rendering establishments in Minnesota when they can be sold at a greater profit for food.

The animals that more particularly need inspection are those suffering from actinomycosis (lumpy jaw), tuberculosis, hog cholera; pregnant animals, etc., etc., etc.

The form of law which we presented to the last legislature to govern meat inspection reads as follows:

A bill for an act for the protection of the public health, by providing for the Inspection and Condemnation of Cattle, Sheep and Swine, slaughtered or to be slaughtered, for the purpose of sale for food, in all counties of the State of Minnesota having a population of more than fifty thousand inhabitants, and in all incorporated cities, villages and boroughs having a population of more than two thousand inhabitants, and situated outside of said counties.

Be it enacted by the Legislature of the State of Minnesota.

Section 1. All cattle, sheep and swine, hereafter slaughtered for the purpose of sale for food, in any of the counties of the State of Minnesota having a population of more than fifty thousand inhabitants, and in any incorporated cities, villages or boroughs having a population of more than two thousand inhabitants and situated outside of said counties, shall be inspected, both before and after slaughter, under such rules and regulations as the state board of health and vital statistics shall prescribe, for the purpose of determining whether said cattle, sheep and swine have been affected by infectious diseases and are unfit for food.

Sec. 2. Upon the passage and approval of this act, it is hereby made the duty of the state board of health and vital statistics, and it is hereby authorized and empowered to appoint one inspector for each of said cities, villages and boroughs, who shall reside therein, and one inspector for each of said counties, who shall reside therein. Said board shall from time to time appoint such deputy inspectors as it deems best; and all provisions of this act relating to inspectors shall apply to their deputies, except that each deputy shall make report to the inspector of the city, village, borough or county, from which he is appointed, instead of to said board, and shall act in the name of such inspector, and his acts shall be recorded in the records kept by such inspector, and he shall pay the fees collected by him over to such inspector. Each inspector shall promptly report to said board any failure on the part of each deputy in the performance of his duties.

Each inspector before his appointment shall pass an examination as to his qualifications for the position satisfactory to said board, and said board shall issue to him a certificate, under seal, stating that he has passed such examination and has received the appointment.

Before entering upon his duties, and at the time of receiving such appointment from said board, each inspector shall take an oath and shall give a bond in the penal sum of one thousand dollars, running to the State of Minnesota, for the faithful performance of his duties. Said board shall be executed by at least two sureties, who shall each justify in the sum of one

thousand dollars, and said bond, with the sureties thereon, shall be approved by the president and secretary of said board, and their approval in writing indorsed thereon. Said board shall cause said bonds and said oaths to be filed in the office of the secretary of state, together with a duplicate copy of the certificate of appointment, within ten days after such appointment is made. In case said instruments are not so filed, said appointment shall be void. All such bonds, oaths and certificates of appointment shall be recorded by the secretary of state in books to be kept for that purpose, and the record thereof is hereby made of the same force and effect as the originals.

Sec. 3. It shall be the duty of each owner of cattle, sheep or swine, who desires to have the same slaughtered and the product therefrom sold for food purposes, within the territory covered by the terms of this act, to apply to the inspector of the locality where the slaughter of said animals is to occur or the product therefrom is to be sold, to have said animals and the product therefrom inspected. In case of his failure to do so he shall be guilty of a misdemeanor, and upon conviction of such offense he shall be punished by imprisonment for not less than ten days and not more than thirty days, or by a fine of not less than five dollars and not more than twenty-five dollars, or both.

Sec. 4. It is hereby made the duty of each inspector, whether the owner has requested it or not, to inspect each of said animals slaughtered or to be slaughtered for the purpose of sale for food within his territory, before slaughter, and the product therefrom after slaughter, for the purpose of determining whether said animals and the product therefrom are affected by infectious diseases, and whether they are sound and wholesome and fit for food. In making such inspection each inspector shall use such tests as the said board may direct, and shall follow strictly all rules and regulations laid down by it. If, upon inspection before slaughter, after the proper examination and test has been made, the inspector is satisfied that the animal is affected with an infectious disease, and that the meat therefrom would be unwholesome and unfit for food, he shall immediately condemn said animal, and place it in quarantine separate and apart from other animals, where it shall be killed and its carcass shall be buried, burned or rendered, and the product disposed of under the direction of the inspector. In case the owner thereof shall request another inspection after the animal has been killed, the inspector shall make the same upon the payment of his fees for both inspections and the expenses of the care and destruction of the animal, and if, upon the second inspection, the inspector shall decide that the animal was not affected by an infectious disease, and that the products therefrom were not unwholesome and unfit for food, the second inspection shall control, and the products therefrom shall pass inspection for sale. If, after proper test and examination, the animal is found by the inspector to be free from infectious disease, the inspector shall pass it for slaughter.

After any such animal, passed for slaughter, has been killed, the inspector shall at once cause it to be duly examined and tested, for the purpose of determining whether or not the animal was affected by an infectious disease, and whether or not its meat is wholesome and fit for food. If, after the proper examination and test, he is satisfied that the meat of such animal is unwholesome and unfit for food, he shall condemn the carcass of said animal and cause the same to be buried, burned or rendered, otherwise he shall

pass the meat therefrom for sale. If such carcass is rendered, the product therefrom shall be disposed of under the direction of the inspector.

Sec. 5. Each animal or piece of meat examined and condemned by an inspector shall be tagged, stamped, and marked by him as condemned, and each animal or piece of meat which passes inspection shall be tagged, stamped and marked by the inspector as having passed examination and as saleable. Each tag, stamp or mark affixed by the inspector shall be plainly marked with his name and the date and place of inspection.

Whenever any animal or meat passes inspection as herein provided, the inspector shall issue to the owner, or to the person having the same in charge, a certificate stating that fact, and that said animal or meat is saleable, which shall be signed by him and dated on the day of its issue. All such certificates shall be made and issued in triplicate, one to be kept in the office of the inspector, one to be sent to be filed with said board, and the third to be delivered to the owner or the person having said property in charge.

Sec. 6. Each inspector shall enter in a book to be kept by him for that purpose a record of all animals and meat inspected. Such record shall show the number of animals and the number of pieces of meat inspected, the time and place of inspection, the name of the owner, the name of the person at whose request the inspection was made, the name of the person in whose custody the animal or meat was at the time of inspection, the fees charged, and the fees received for such inspection. The record shall also show, in each instance, whether the animal or meat, as the case may be, was condemned, or whether it passed inspection, and if condemned, when and where destroyed. The records shall be kept in the office of the inspector, and shall be delivered by him to his successor in office, or to the board, together with all books, papers and correspondence relating to the business of such office. Whenever, and as often as any record book shall be filled, the same shall be sent by the inspector to the secretary of the board, and the same shall be by said board preserved. Said board shall at all times have access to the books, records, papers and documents in the office of each inspector.

Sec. 7. Each inspector shall make a full and complete report of all his acts to said board at the end of every month. Said report shall contain a statement of all matters required by this act to be set down in the record book of the inspector, together with such other facts as said board may require, and also such other matters as the inspector may deem best.

Sec. 8. Each inspector shall pay over to the secretary of the board, at the close of each week, all fees collected by him under the provisions of this act. The secretary of said board shall pay all such fees, monthly, into the state treasury, and the state treasurer shall place and keep them in a fund which is hereby established, to be known as the "Animal Inspection Fund." All money paid into said fund shall be used exclusively to pay the fees established by this act, and to defray all the expenses contemplated hereby or incident to the inspection herein provided for.

The state treasurer shall from time to time disburse the money in said fund upon the order or requisition of said board, and not otherwise. Said board shall keep true and correct books of account in which shall be set down all items received and paid out under the provisions of this act. It shall include in its annual report a complete statement of all fees so received and disbursed.

Sec. 9. No inspector shall, during his term of office, traffi, either directly or indirectly, in any cattle, sheep, swine, or in any product therefrom.

Sec. 10. It shall be the duty of each inspector to enter complaint before any court of competent jurisdiction against any person who shall violate any provision of this act.

Sec. 11. Each inspector shall hold office until his successor has been appointed and qualified; provided, however, that any inspector may be removed at any time by said board by a majority vote thereof.

Sec. 12. Each inspector shall collect from the owner of the animals or meat inspected, or from the person in charge, and he shall pay to the inspector upon demand at the time of the inspection, the following fees, viz.: For all cattle inspected before slaughter, ten cents per head, and for the inspection thereof after slaughter, five cents per head. For all sheep and swine inspected before slaughter, three cents per head, and for the inspection thereof after slaughter, two cents per head. For all cattle inspected after slaughter, but which have not been inspected and marked before slaughter, twenty cents per head. For all sheep and swine inspected after slaughter, but which have not been inspected and marked before slaughter, ten cents per head. For one hundred pounds, or fraction thereof, of beef, not marked as having theretofore duly passed inspection, five cents. For each one hundred pounds, or fraction thereof, of pork, mutton, lamb, veal, or smoked meats, not marked as having theretofore duly passed inspection, ten cents.

Provided, however, that when it appears from an inspection of a condemned animal after slaughter that the animal inspected ought not to have been condemned, the inspector shall refund the amount per head collected after slaughter.

For the purpose of aiding the state in the collection of the fees herein provided for it is hereby given, and there is hereby created for its benefit a lien upon each and every animal or piece of meat inspected, or the product thereof, under and by virtue of the terms hereof. In case the fees herein provided for are not promptly paid to the inspector at the time of the inspection, he is hereby authorized and directed to seize and sell the animal or meat inspected, or the product thereof, at public or private sale, without notice, and after deducting from the amount received on such sale the fees herein provided for, and all expenses incurred in making such sale, to pay over the balance to the person who owned such animal or meat at the time of the seizure, or from whose possession the same was taken.

Sec. 13. Each inspector shall receive, as compensation for the performance of his duties as prescribed by this act, seventy per cent of all fees directly collected by him, and ten per cent of all fees collected by each of his deputies, and each deputy shall receive, as compensation for his services, sixty per cent of all fees collected by him. The remainder of the inspection fees provided for in this act shall be used for defraying the expenses incurred in carrying out the provisions of this act, it being the intention hereof to make the fees provided for herein pay all expenses incurred hereinunder.

Sec. 14. The sale of beef, mutton, lamb, veal, pork or smoked meats for food, within any of the territory covered by the provisions of this act is hereby prohibited, unless the same shall have been first inspected and passed inspection and marked with the marks herein provided for. Any person who shall sell, expose, or offer for sale, for food, any such beef, mutton,

lamb, veal, pork or smoked meats, contrary to the provisions of this act, shall be deemed guilty of a misdemeanor, and upon conviction thereof, shall be punished by a fine of not less than twenty-five dollars and not more than one hundred dollars, or by imprisonment not exceeding three months for each offense.

Sec. 15. Any inspector who shall falsely tag, stamp, or mark any animal, carcass, or piece of meat, or who shall make any false certificate in respect thereto, shall be deemed guilty of a felony, and upon conviction thereof shall be punished by a fine of not less than five hundred dollars, nor more than one thousand dollars, or by imprisonment in the state prison for a term of not less than one year nor more than three years.

Sec. 16. Any person who shall counterfeit any tag, stamp or mark, used by an inspector, or who shall change any tag, stamp, or mark placed upon any animal or meat by an inspector, to any other animal or piece of meat, or who shall affix any tag, stamp, or mark to any animal or piece of meat without the authority of the inspector, shall be guilty of a misdemeanor, and upon conviction thereof shall be punished by a fine of not less than twenty-five dollars nor more than one hundred dollars, or by imprisonment for not less than sixty, nor more than ninety days.

Sec. 17. Each inspector is hereby authorized, and shall have full power and authority to enter all cars, buildings or other places of business, and to open all packages of whatsoever nature, kind or description, and examine the same, in the proper performance of his duties.

Sec. 18. Nothing herein contained shall require the inspection of any meat from animals which have been inspected under the laws, rules or regulations of the United States, unless such meat is sold, exposed or offered for sale, within the territory covered by this act, in which case the same shall be subject to inspection as herein provided.

Sec. 19. Nothing herein contained shall require any person residing within the territory covered by this act to have any animal, or the product from any animal, slaughtered for his own use, inspected, and the meat from such animal shall not be subject to inspection hereinunder, unless sold, exposed or offered for sale within said territory.

Sec. 20. Nothing herein contained shall be construed to require the inspection of salt, pickled, or canned meats, of any kind, except smoked beef, tongue, ham; bacon, sides and shoulders.

Sec. 21. In making the inspection of slaughtered animals herein provided for each inspector shall particularly examine and test the head, liver, lungs, spleen and tongue of each animal slaughtered; and for better enabling him to do this, the butcher shall hang the same upon racks provided for that purpose in the slaughter house where the slaughtering is done, immediately after the slaughter and removal from the carcass of the animal slaughtered, and each of said organs shall be marked by the butcher in such a manner as to be easily identified as coming from the carcass from which it has been removed, and said organs so placed shall remain there until after inspection by the inspector.

At least one inch of the diaphragm or skirt of the carcass of each slaughtered animal shall be left on the animal slaughtered until the same has been examined, inspected and passed, and all the parietal pleuræ, or the lining of the chest cavity, and the parietal peritoneum or the casing of the abdominal cavity, ordinarily removed in the process commonly known as

"stripping," shall remain upon each carcass, and shall not be removed therefrom until after the inspector has made his examination and inspection.

Sec. 22. Whenever any inspector shall condemn any meat after slaughter he shall saturate the same with such chemical agents as will prevent its sale for food.

Sec. 23. The number of inhabitants of any county, city, village or borough, in the state, for the purpose of this act, shall be determined by the last state census. Whenever and as often as any state or national census shall show that any county, city, village or borough in said state, not now having a sufficient population to come within the provisions of this act, has reached the population herein provided for, it shall immediately come within the provisions of this act, and said act shall apply thereto. Whenever and as often as any state or national census shall show that any county, city, village or borough has fallen below the population required by the provisions of this act, the provisions of this act shall not apply thereto, and the office of each inspector and deputy inspector shall be immediately terminated. Provided, however, that the last census, whether it be state or national, shall always control the question as to the population in any county, city, village or borough.

Sec. 24. All records, papers, documents and instruments herein provided for are hereby made competent evidence to prove the facts therein stated.

Sec. 25. The said board may from time to time require any inspector to give such other, further, or additional bonds as it may deem best. It may from time provide, establish and put in force such additional rules and regulations for the carrying out of the provisions of this act as it may deem best, provided the same do not conflict herewith.

Sec. 26. Any person infringing this action in any particular not heretofore specified shall be guilty of a misdemeanor, and upon conviction shall be punished by a fine of not less than ten dollars nor more than twenty-five dollars, or by imprisonment for not less than ten days nor more than thirty days.

Sec. 27. The word "person" whenever used in this act shall be considered and construed to include individuals, firms, corporations and their officers, agents, servants and employes.

Sec. 28. All acts and parts of acts inconsistent herewith are hereby repealed.

Sec. 29. This act shall take effect and be in force from and after the first day of June, A. D. 1899.

SLAUGHTER HOUSES.

That some system of slaughter house regulation and meat inspection throughout the state is necessary is demonstrated by the following communications:

———————, Nov. 15, 1897.

To the State Board of Health:

On the land of ———————, about one-fourth mile from the village, is located a slaughter house, the yard around which extends to the river's bank. But a short distance below the slaughter house there is a dam, and from

this pond is collected the village ice supply. Dead hogs, but partly buried, are now lying in this yard, close to the water's edge. Outside of the yard fence is a pile—say one or two wagon loads—of decaying bones and offal. Inside the yard is a hole about four by six feet, and five feet deep. Into this has been thrown the offal from slaughtered animals. Still other offal not in the places already described lies where it was shoved out of the house. Inside the house, in barrels, is a lot of stinking fat. I visited the place last Sunday, and had to keep on the windward side; could not stop in the house where the barrels of stinking fat were at all. Often during the past summer we could not work in the field near by when the wind was in the west. The stench also comes to our dwelling house, and is very offensive. When it rains or when snow melts, the blood and filth is washed from this yard into the river and is carried to the pond near by where the village ice supply is collected.

Respectfully,

————————.

It is worthy of note that the above description of a typical country slaughter house was written in *November*, when such nuisances should be least offensive. I visited this place, and found it quite as filthy as represented in the above description. Various attempts have been made to make the owner of this place keep it clean, but he neglects to do so, and defies those whose duty it is to enforce the laws of sanitation. The chief meat supply for a village of over two thousand inhabitants is obtained from this vile place. Our chemist when on his survey last summer condemned the ice supply taken from the pond described as receiving the drainage from this slaughter house.

Here is another description of a country slaughter house supplying a village with a population of about five hundred:

————————, July 17, 1899.

Dr. Bracken, Secretary State Board of Health,

MY DEAR DOCTOR: The health board of the township called upon the village board to-day to inspect the slaughter house of ————————, outside the village limits. It was a terror to civilization! A pile of offal made the place almost unapproachable, and the swarm of flies attacked one so fiercely that it seemed almost impossible to pass through them. The slaughter house has a hog pen extending on three sides, strewn with offal. Evidently no water is used about the place. The owners depend upon the weeds, which grow from six to ten feet high, for protection from observation. The board has kicked against such a state of affairs, has hired an attorney, and now wishes to do all that it can to suppress such a place.

Respectfully,

————————, M. D.,
Health Officer.

The efforts in the above case secured a temporory "clean-up" only.

Below is a description of a place I saw on the outskirts of a city with a population of ten thousand:

July 5, 1899, I visited the place of ——————, and found the following condition: Just outside and in front of the slaughter house was a deep pit, and in this was a mass of decaying animal matter, covered with maggots and flies. The yards outside the slaughter house were filthy in the extreme. Hogs were being fed here contrary to the regulations of the state board of health. The slaughter house was in a filthy condition. The manure piles about Mr. ———— sheds should have been removed long before this season of the year. The shed where the butchers keep their cattle awaiting slaughter was simply a mass of mud with a roof over it.

Following is the description of the slaughter houses supplying one of our older cities, having a population of about eight thousand, —a city in or near which are several church schools, state institutions, etc.:

——————, June 18, 1900.

The slaughter house of ——————, in the ——————part of the city, is the one where the greatest number of animals are killed. At the north end of the building is a portion of ground that has been flagged with stone, and from this leads a hollow, about three feet wide, intended to serve the purpose of a drain; but judging from its present appearance it has never fulfilled its function,—at least, it does not drain away any blood or other waste material now. On the contrary, the blood and washing run in the opposite directions and furnish the only "wallow" for hogs in the field near by. This was an exceedingly foul place. The meat after being dressed hangs here for a time subject to this foul odor and to the swarms of flies that at this time of the year infest such places. We next visited the place of ——————. Here we found everything filthy,—from the heads of slaughtered animals to the bodies of calves whose mothers were slaughtered before they were born, as well as the carcass of a hog which had died before its owner had an opportunity to kill it.

One should not overlook the fact that in the neighborhood of our larger cities are located filthy country slaughter houses, in which animals that would not pass inspection are killed and placed upon the market as food.

While these descriptions apply to the ordinary country slaughter houses, there are a few places in the state where conditions are not so bad. Winona, while not furnished with ideal buildings in which to slaughter, is the pioneer city, probably, in having the surroundings of its slaughter house in a somewhat reasonable sanitary condition.

STATE INSTITUTIONS.

Certain general principles should be observed in the location, construction and equipment of all state institutions. In nearly every instance the buildings are for the accommodation of large aggregations of people. They may be for the accommodation of the sick, as represented by our hospitals and asylums; for the unfortunates, as represented by the schools for the blind and the dumb; for the defectives, as represented by training schools and reformatories; or for the criminal, as represented by our jails, penitentiaries, etc.

The tendency in all institutions for the care of any of these groups should be moral elevation. There can be no moral elevation with filth and slovenliness about. Even the most degraded are susceptible to the influences of cleanliness and orderly methods. In no place is the old saying, "Cleanliness is next to godliness," more applicable than in public institutions. The first important point in locating an institution is to choose a site with good drainage, good water, good air and pleasant surroundings. The next important point is the selection of a suitable design for the buildings. In this the architect should not hold first place unless he is capable of giving first consideration to his plans as a utilitarian. I do not mean by this that the aesthetic must be ignored; far from it; but the true architect must be both utilitarian and aesthete. The general principles involved are durability and cleanliness. The exterior of buildings is of minor importance; the character of the interior is everything.

It was my privilege a few years ago to visit the second hospital for the insane of Maryland. A noted sanitarian, Dr. George H. Rohe (now dead), was made superintendent of this institution, and it was he who influenced the choice of location and the style of buildings. The property consists of over seven hundred acres of beautifully undulating country, with ideal building sites for single pavilions or groups of cottages. It is the chronic insane that are cared for at this place.

The first group of buildings (the only ones completed at the time of my visit, in the spring of 1898) is arranged in the form of a quadrangle, the service building facing west and the cottages north, east and south respectively. "The construction and arrangements of these buildings embrace many radical departures from the cus-

tomary methods of construction of hospitals for the insane," yet they are believed to embody the most advanced and enlightened ideas of the age. The exteriors of the buildings are inexpensive and simple in treatment, being constructed of a good quality of red brick, with brown stone and brown terra cotta trimmings. The living rooms, on the first floor, have French windows, opening to the floor. All division and side walls are of brick. There is no plastering of any kind except on the ceilings of the basements and of the second floor. The inner walls are painted.

The principal entrance for the patients is through the basement, which contains wash basins and toilets, as well as rooms for boots, shoes and soiled outer clothing.

The service building contains offices, drug rooms, etc., for the resident physicians. This group of buildings was for the accommodation of male patients. In 1899 a new group of buildings for female patients was constructed. These last three cottages are almost the counterpart of those in the group of buildings for men, but they were constructed at considerably less cost.

I have gone thus fully into detail in speaking of this hospital for the insane because it has many ideal features, and because it presents such a marked contrast to at least one of our recently built hospitals for the chronic insane—the one at Anoka. This hospital, less than two years old, has already the appearance of an old building. It has plastered walls, already cracking; wooden baseboards, harbingers of vermin and filth; and other undesirable features. In such a hospital, where many of the patients are employed in out-of-door occupations, there should be a generous provision of baths and closets. We do not find such at Anoka. In fact, there is little in the construction or arrangement of this hospital that commends itself to a sanitarian. Fortunately not all of our state institutions are such marked sanitary failures as is this hospital. Many of them have model arrangements along certain lines that are to be highly commended.

It should not be permissible in this age for any individual to make grave sanitary errors. In connection with the construction of state institutions there should be a building committee composed of men thoroughly familiar with their practical needs; and on such a committee sanitarians should have a fair representation. No state building should be constructed without the approval of such a committee.

It goes without saying that many of our jails, lockups and county poorhouses are a disgrace to civilization, and especially a

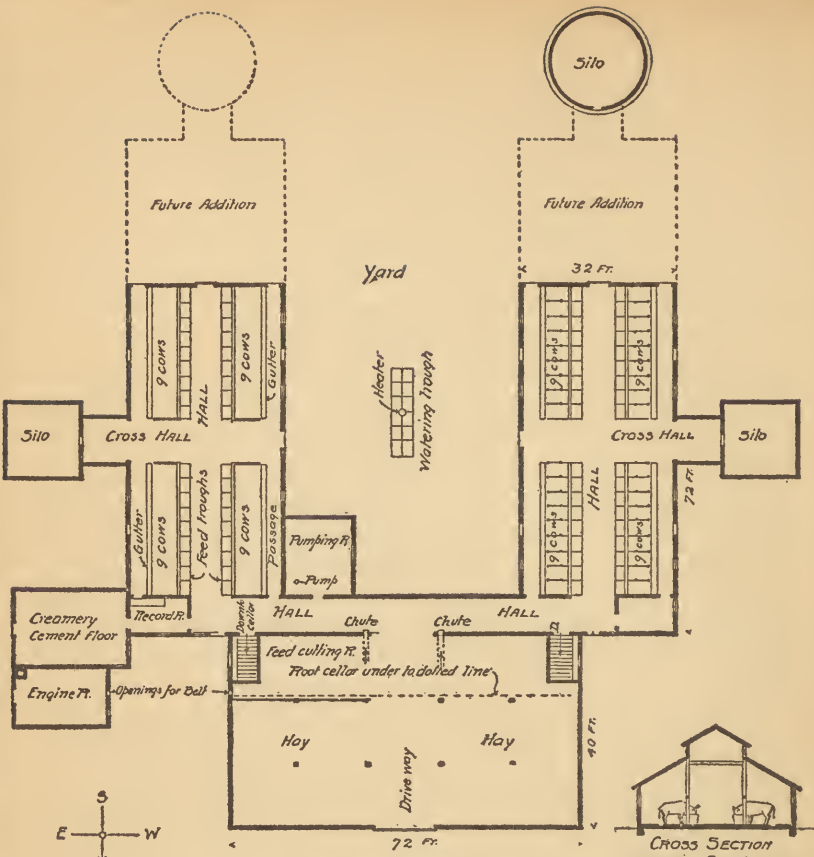
disgrace to a new state like Minnesota, that should have profited by the mistakes of older states. The only comfort for us is the fact that ours is not worse than other states.

AN IDEAL COW BARN.

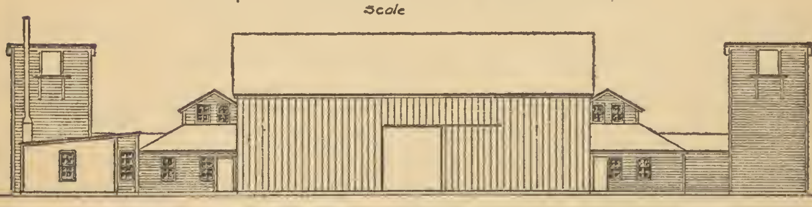
In these days, when we recognize bovine tuberculosis as a possible source of infection of mankind, it behooves us to see that our dairy cattle are not tuberculous. It is necessary, therefore, that we should not only exclude tuberculosis from our dairy herds by means of the tuberculin test, but that we should properly house them in order to keep the healthy cattle in good condition. Again let me refer you to the farm at the school for the feeble-minded for an ideal building,—a cow barn,—shown in the accompanying illustration. In its construction the sanitary requirements of the cow have received careful attention. The building is well lighted, has an abundance of air space and is conveniently constructed for keeping clean. The feeding arrangements are excellent. The stalls give the greatest amount of comfort possible to an animal under restraint. Here it is also possible to carry out the other necessary details for the collection of a clean milk supply (and I can assure you this is done at this school). The milkers have opportunity to clean up and don their clean clothing before they commence to milk. Still further: the condition of each cow can be closely watched, for the milk is collected separately and carried to the "record room," where its quantity and other data are recorded. Any variation in the milk supply of a cow from day to day is readily noted, and made the cause for inquiry. I venture to say there is not a cow barn in this state superior in construction to this one, judged from a sanitary point of view, and fews its equals in this or any other state.

As the cows have all been passed upon by the tuberculin test, there is little danger of the children in this home contracting tuberculosis from the milk given them. Would that as much could be said for children not in a state institution. Compare with this ideal cow barn the place in which dairy cattle are usually kept. Low sheds, with little light or air; banked up with manure, in order that the cattle may be kept warm and produce the maximum quantity of milk; often with miserable floors, the cattle standing in a reeking, filthy mass of liquid manure; the odor of the atmosphere intolerable; quantity of pure air entirely too low; the whole atmosphere highly unfavorable to the health of the animals.

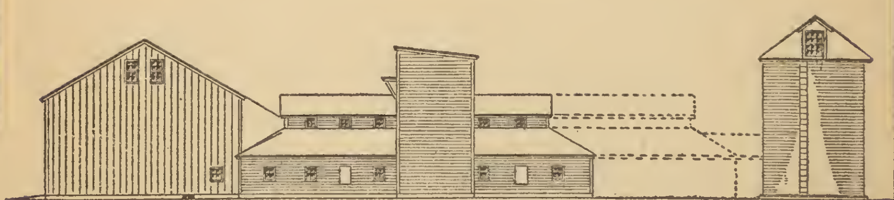
Add to this condition the milking of cows with manure-covered udders, by milkers with dirty hands and clothing. This picture represents methods entirely too frequently followed out in caring for cows in large numbers, that furnish milk for our city and village purchasers, as well as to the creameries. It is not only those who purchase milk and its products who suffer by such negligence in the choice and care of cows. One of the most careful and observing physicians in this state has reported upon the frequency of certain forms of tuberculosis amongst people in farming communities, and has raised the question as to whether the cause of such a condition might not be found in the milk supply. It would seem that, with our present knowledge of tuberculosis and the various sources of infection, one source might be cut off by the proper care of our milk supplies. The tuberculin testing of cattle is not enough. We must have clean and airy dairy barns as well. This may necessitate raising the price of milk, but safe milk at any price should be sought after rather than disease-bearing milk at any price..



PLAN OF GROUND FLOOR



FRONT ELEVATION - NORTH



SIDE ELEVATION - WEST

COW BARN AT STATE SCHOOL FOR FEEBLE-MINDED - FARIBAULT - MINNESOTA

December 1900

TRANSPORTATION OF THE DEAD.

The system of licensing embalmers, established by this board in 1898, has proven very satisfactory. The examinations in 1899 and 1900 were held at the close of the Tri-State Embalmers' Association meetings and were of both a theoretical and practical nature. At present there are 196 embalmers holding our license, having residence as follows:

Minnesota.	North Dakota.
Wisconsin.	South Dakota.
Iowa.	Montana.

The embalmers have taken a lively interest in the study of disinfectants, especally in relation to embalming fluids. At their meeting in September, 1899, a committee was appointed to work with the bacteriological laboratory of our board, and with Dr. C. A. Erdmann, professor of anatomy, University of Minnesota, in the investigation of the bactericidal properties of embalming fluids. The results were quite satisfactory. The fluids, bought in the open market by the committee and marked with numbers only, were injected under the direction of Dr. Erdmann, and the bodies thus injected examined culturally at our laboratory. The results demonstrated that embalming fluids, when of good qualtiy and properly used, had bactericidal properties. The work of the committee is to be continued during the coming year. It is difficult to find good men in the smaller cites and villages who can carry out proper methods of disinfection in houses in which have been patients suffering from an infectious disease. Modern embalmers are well equipped with the latest disinfecting appliances, and are familiar with the work required for thorough disinfection of the sick room. In many instances they have taken up this work to the great advantage of their communities.

My ideas as to the possibilities of the embalmer as a sanitarian are represented in the following paper, which was read by request at the meeting of the National Funeral Directors' Association at Denver, October, 1900:

THE EMBALMER AS A SANITARIAN.

There are certain conditions which appear contradictory. It is difficult for many people to understand why physicians should be interested in preventative medicine; in destroying their own means of gain, as it were. Yet it is a fact that all true physicians are constantly using every means in their power to control and prevent the recurrence of infectious diseases.

It may be difficult for many to understand the relationship of embalmers as a class to preventative medicine. They are associated only with the care of the dead. In a jocular way, it has been said in the past that physicians and embalmers worked together; that the physician made employment for the embalmer; that the embalmer covered up the mistakes of the physician. We can no longer confine ourselves to this jocular relationship between those who have the care of the dying and the dead. They can now be found working along the same lines in an effort to prevent disease, apparently working against their own business interests.

Why is it that an embalmer is, and should be, interested in preventing disease? It is said by some selfish people that all motives are selfish. It often happens, however, that a motive originally selfish has eventually an unselfish result. Self-protection is an inherent incentive to action for all of us. It is necessary for the embalmer to prepare for burial the remains of those who have died of infectious diseases. There is danger that he may contract disease or convey it to others. When compelled by his calling to care for the remains of those who have died of a communicable disease, selfish interests make him careful He does not want to be ill; he does not want to convey disease to his own family or friends. He cannot afford to be careless, for should the public feel that an embalmer was indifferent in his methods and a possible source of infection, he would be shunned and his business interests would suffer in consequence. It is self-protection, therefore, that gives the first suggestion to the embalmer to become a sanitarian. Having an incentive, he studies the needs of the case. He learns that there is danger in the air of the sick room; in the contents of the room; in the clothing and bedding of the dead person; in the corpse itself. He learns that there is a difference in the degree of danger from various diseases; that the danger from smallpox and scarlet fever must be met in one way, while the dangers from typhoid fever, tuberculosis, diphtheria, syphilis, etc., may be met by quite a different line of action. He learns how to make the room safe to enter; how to clothe himself for safety; how to care for infected articles; how to care for the remains of the dead in order that they need be no longer dangerous to others. He must apply some of this knowledge in all cases of death from an infectious disease for his own safety, and in order that he may be allowed to remove the remains for burial.

With a knowledge of disinfection, and the necessity of applying it to some extent for his own safety, why should not the embalmer use it to the full limit, as demanded, for the safety of others? Whom do we expect to have an intelligent knowledge of disinfectants and the methods of disinfection? Physicians, trained nurses, trained disinfectors and embalmers. Physicians rarely make good disinfectors. They will not do the work themselves. Their instructions are often fragmentary and imperfect, dealing with generalities, and given to people who know little and

care less about disinfection. Disinfection under a physician's direction is often a farce practiced only to comply with sanitary laws. The danger after the farcical performance is even greater than before, for a feeling of false safety is given, and people who had previously avoided the dangerous places no longer shun them, although the danger has been little, if at all, reduced. A trained nurse might carry out the greater part of a successful disinfection after the recovery or death of an infectious patient; but how often is there no trained nurse at hand? Even with such a person to look to, the work cannot be done without proper disinfecting apparatus, and this, of course, does not belong with the nurse's outfit. Trained disinfectors, who make disinfecting their business, are rarely found except in large cities, and even here they are apt to be political parasites working under the supervision of political sanitarians. The embalmer is, or should be, everywhere It is necessary for him to be thoroughly equipped in order to practice disinfection in his own interest. He should be a responsible party. If he does not want to do the work himself, he has competent assistants who should be able to carry out his orders intelligently—assistants who are in no way ordinarily disinfectors under a physician's direction, or who are too often in the employ of local boards of health. Still, further, the embalmer has of necessity to be equipped with a disinfecting outfit, more complete than that found in the office of the physician or of the ordinary sanitary authorities.

Note to what disinfection must be applied in dealing with infectious diseases, and then see who is best prepared to do the work; rooms, furniture, bedding, clothing, the patient or remains, demand attention.

The first disinfection of a room requires the use of formaldehyde. The embalmer is more likely to have a formaldehyde generator than is any other individual, and he knows how to use it. He is probably the best prepared and most competent available person to carry out this work. After the aerial disinfection of a room it is necessary to sort out its contents, and to know what should be destroyed and what may be saved by further disinfection. It is also necessary to be familiar with the nature of the infection, for the methods of disinfection are governed by such knowledge. Next to the physicians the modern embalmer should be the best informed individual on such matters, and it should be in his power to give such personal supervision as to see that the work is properly done. It is not necessary that he should sort clothing, wash walls and furniture, scrub floors, etc., if he does not wish to; but with a knowledge as to how such work is to be done properly he can direct others. He should know that thorough boiling of clothing for thirty minutes is safe and thorough disinfection; that the heat must be uniform, and that it will take more time to bring the temperature of the interior of the mass of clothing to the boiling point than of the surface. He should know that it is not wise to depend upon aerial disinfection of a room with formaldehyde, and to make all things doubly sure, all woodwork, furniture and floors should be washed with a solution of corrosive sublimate, or other equally sure disinfectant. He should know that the corrosive sublimate has an injurious action upon metals and that solutions of this drug should never be used upon metallic surfaces or in unprotected metallic dishes. He should know that all disinfectants are poisonous, and should not be handled carelessly, nor left in solution where innocent people might by chance use them accidentally in such a way as to cause death.

He should know that it is almost, if not quite, impossible to disinfect in the cracks of the walls or behind loose wall paper with either aerial disinfectants or drugs in solution, and that, therefore, after a room has been as thoroughly disinfected as possible by ordinary means, it is wise to recalcimine, repaint or repaper the walls, and to repaint the woodwork. He should know that sunlight and fresh air are excellent adjuncts to the various methods of house disinfection, and that the more of these that are used in the final clean-up the better and safer it will be for the future occupants of the place.

You may say that I have outlined requirements that are impossible of fulfillment in the majority of places requiring disinfection. Granted. It is our duty, however, to take a high standard for our working basis. If we cannot reach it always, we must do the best we can in each case. If we try to come as near as possible to our standard in each case, we will find the desired result will be attained more frequently than we could imagine possible were we to take "I cannot" for our motto.

The disinfection of the patient is as important as that of the room and its contents. It is often that the sick one is apparently well long before he ceases to be a menace to others. It must be borne in mind that quarantine is for the benefit of the well, and not for those already infected. Quarantine must, therefore, be maintained until all infectious material has disappeared from the patient. This means for small-pox, scarlet fever, and like diseases, until all desquamation is completed, and for diphtheria until the germs of the disease are shown bacteriologically to be no longer present in the nose or throat, or other surface that may be involved. When the patient is declared by a competent physician to have recovered, and to be no longer a menace to public health, there should be a thorough cleansing of the body and a complete change of clothing, using, of course, articles that have in no way been contaminated with infectious material.

But you may say, disinfection is menial work. I will reply, that it is what you make it. There are now physicians of good standing who act as disinfectors. They do not degrade themselves nor their calling by so doing. They are practicing one branch of preventative medicine, and you need not be ashamed to work with them along these lines.

So far we have been dealing largely with conditions where the embalmer may take part as a sanitarian or not, as he may choose; but we now have to consider conditions where it is imperative that the embalmer shall be a sanitarian. If a patient dies, it then rests upon the embalmer to see that the remains are so prepared as to be absolutely safe for shipment from one end of the earth to the other, without a casket or other similar covering. It is possible to find embalming fluids that disinfect the body thoroughly. It is possible to make such thorough injection as to bring about complete disinfection. With such possibilities it is your duty to see that this is done. With a body properly injected, the body orifices properly sealed, the surface of the body thoroughly cleansed, the remains of those who have died of a communicable disease are no longer a menace to the public. This, again, is an ideal, and it will be some time before the external precautions now in use—the cotton covering the hermetically sealed casket, etc.—can be entirely abolished, but the more we strive to bring about the ideal the sooner it will come.

Of what avail is a hermetically sealed casket when it has been broken open in a railroad wreck?

The strength of a chain is that of its weakest link. The danger from infection in the shipping of the dead is that of the most poorly prepared body. The question as to whether the remains of all who have died of a communicable disease should be disinfected is a pertinent one. There can be but one answer—yes. No one can tell when it may be necessary to disinter a body. The desire of friends to change the place of burial; the abandonment of an old cemetery, and removal of the dead to a new resting place; the disinterment of the dead for medico-legal purposes; the danger of pollution of drinking water—all these and other reasons demand the disinfection and the proper embalming of all who have died of a communicable disease, at least. It would be well if it were a sine qua non that all dead should be cremated (the most thorough disinfection for the dead that we have at our control) or thoroughly disinfected and embalmed.

Recognizing the fact that it is the duty of the embalmer to prepare the remains of all those who come under his care for burial so that they cannot possibly be sources of danger, it will be well to give attention to certain specific diseases; to note the source of danger for each, and the best method of combating it.

Asiatic Cholera—This is fortunately an uncommon disease in this country. The dread of cholera is so great that cremation is generally approved of as a means of disposing of its dead victims. When this disease prevails in epidemic form, burial of its victims is generally of the most primitive. The ideal is not attainable. It should be, and is, quite possible to so thoroughly disinfect and embalm the remains of one who has died of cholera as to make their shipment quite safe. The conditions prevailing as to yellow fever, plague, smallpox, typhus fever, etc., are quite similar; but at present the shipment of those dead from any one of these diseases is prohibited.

Scarlet fever is quite as dangerous a disease to deal with from the embalmer's standpoint as is smallpox. The danger of infection is present upon the surface of the body as well as in certain secretions, especially those of the mouth. Not only must the embalmer take every precaution, therefore, to protect himself from possible infection, or serving as a carrier of infection directly, to others, but also to so prepare the remains as not to transport the disease to other parts of the country. He must be exceedingly careful with his embalming, with the washing of the body surface, and also that the cotton envelope is thick enough over all parts of the body.

Diphtheria is looked upon as a disease to be carefully guarded against, while tuberculosis is looked upon lightly and yet the dangers are quite similar. The dangers from the remains of one dead of diphtheria are usually from the secretions of the mouth and nose. If such remains have been properly cleansed externally, properly injected, and the external orifices properly closed with absorbent cotton, there should be no danger from them. Diphtheria secretions, especially from a poorly prepared body, though a leaky coffin, may be a source of inspection to others, followed by acute illness, and even death. The same conditions with the remains of one having died of tuberculosis may also give rise to an infection whch is quite as fatal as that of diphtheria, although chronic in type. In tuberculosis we have even more care to observe than in diphtheria, for the alimentary canal, as well as the

respiratory tract, is often involved, and dangers of infection from this source must be guarded against. There may be even local tuberculosis upon the surface that are capable of conveying disease and death to others. With escaping discharges from a leaky coffin the dangers in the transportation of the remains of those who have died of typhoid fever, anthrax, puerperal fever, erysipelas, syphillis, etc., is much the same as that from diphtheria or tuberculosis.

I have shown you the opportunities open to embalmers to act as sanitarians. Some of these are optional to you; others—the care of the dead—are obligatory. Your future success as a body will rest upon your ability as sanitarians. If you have careless, incompetent or unscrupulous men among you, weed them out, for their methods will taint your entire craft. That you may set your ideals high, and use your utmost to bring them into general use, is the wish of every true humanitarian and sanitarian.

At the meeting of the Tri-State Embalmers' Association in Minneapolis, September, 1900, the following resolutions were presented:

WHEREAS, About two hundred embalmers practicing in the State of Minnesota have passed an examination and been licensed to prepare bodies for shipment upon the railroads in this state, the number of licensed embalmers being nearly one-half of the whole number doing business in this state; and,

WHEREAS, It is quite necessary that bodies of those dead from infectious and contagious diseases shall be thoroughly disinfected by the process of embalming for local interment, as well as for transportation upon the railroads within the state; therefore be it

Resolved, That the president be authorized to appoint a committee on legislation, which committee shall be charged with the duty of preparing such further legislation as may be necessary to enable the state board of health to have supervision of all embalmers, and extend the present license system as soon as possible to all embalmers assuming to embalm bodies, whether for transportation or for local burial.

WHEREAS, Rules and regulations have been made concerning the manner in which bodies shall be prepared for shipment out of the state; and

WHEREAS, Some of the states bordering on Minnesota, and a number of the states from which bodies are shipped to Minneosta, have no such regulations; therefore be it

Resolved, That the state board of health be requested to make rules and regulations which shall prohibit the shipment into this state of any bodies which have not been prepared in accordance wth the transportation rules adopted by the American Association of General Baggage Agents. And be it further.

Resolved, That the state board of health be requested to require of embalmers who are not licensed, and who are privileged to ship certain cases under certain conditions that they make sworn affidavit that they have prepared such bodies for shipment in the manner provided in the rules for the shipment of certain bodies by non-licensed embalmers.

Resolved, That we reaffirm our approval and confidence in the manner in which the state board of health and its executive officer, Dr. H. M. Bracken,

have conducted the licensing of embalmers in this state. We are profoundly conscious that the high rank which Minnesota has taken would not have been achieved but for the whole-hearted suport of the state board of health.

These are reasonable and necessary. With the national rules for transportation in force, it is very important that the shipment of bodies should be most carefully regulated, speaking from a sanitary point of view,—because shipments are becoming more general, and because under certain restrictions the remains of those who have died of certain infectious diseases are permitted shipment. Should any irregularities in shipment from the state occur, a grave, and even possible fatal, sanitary error may have been committed. We cannot therefore be too careful. Taking into consideration the fact that up to 1898 there were no regulations for the shipment of the dead in force in this state except those established in self-protection by the various railroads, we are certainly to be congratulated upon the present conditions.

CHARTS

SHOWING MONTHLY MORTALITIES.

The Average of Eleven Years, 1887-1897, Inclusive Shown in Black.
The Average for the Two Years 1898-1899 Shown by a Red Line.

CHART NO. I.—DIPHTHERIA.
CHART NO. III.—CROUP.
CHART NO. V.—SCARLATINA.
CHART NO. VII.—MEASLES.
CHART NO. IX.—TUBERCULAR DISEASES.
CHART NO. XI.—PNEUMONIA.
CHART NO. XIII.—BRONCHITIS.
CHART NO. XV.—TYPHOID FEVER.
CHART NO. XVII.—DIARRHŒAL DISEASES OF CHILDREN.

CHARTS

SHOWING ANNUAL DEATH RATE PER 100,000 POPULATION FOR TWELVE YEARS, 1888-1899, INCLUSIVE.

The whole state............................ ————————

State outside of cities having over 5,000 population ═══════

Total cities between 5,000 and 15,000 population ....

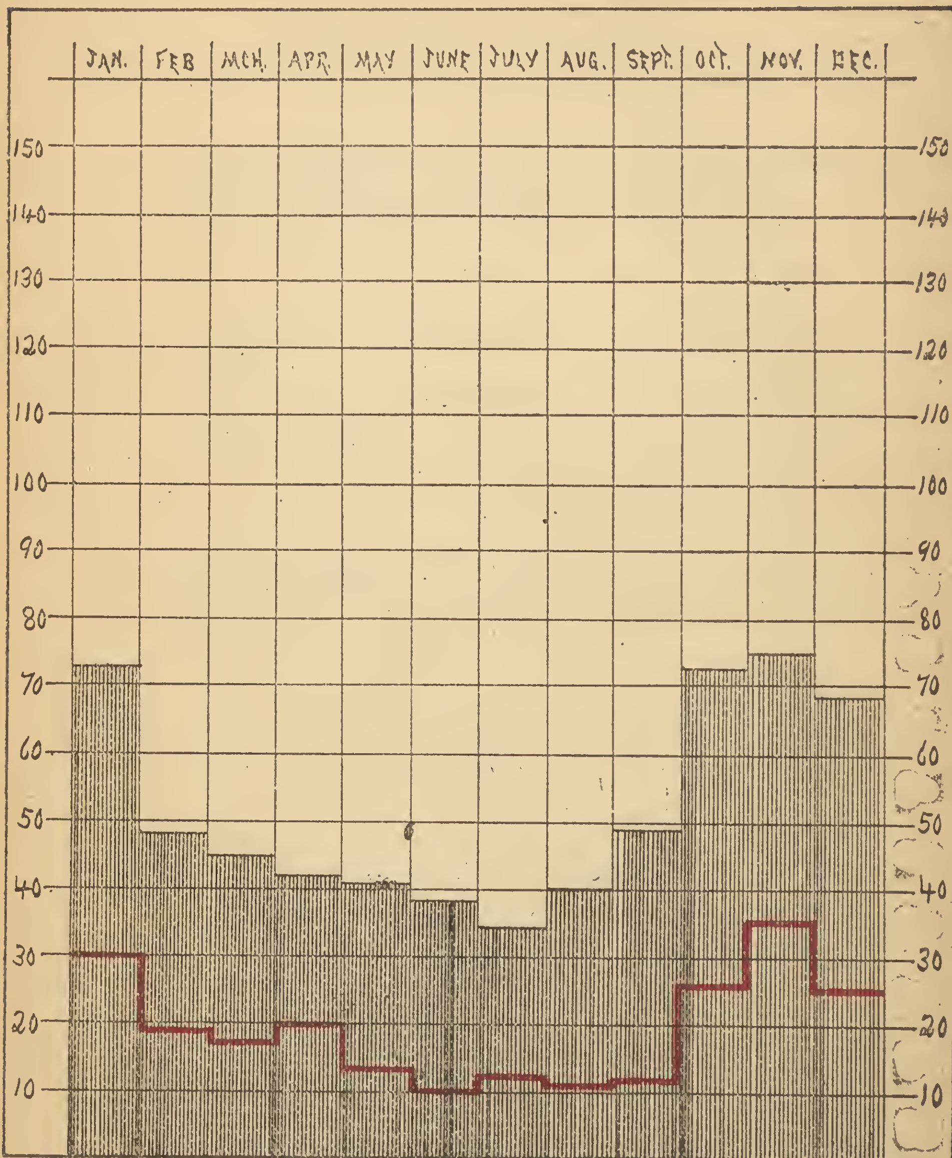
Total cities over 15,000 population .... — — — — —

NOTE.—The population of the above for each year is estimated by adding the average annual increase, as shown by the United States census of 1880, 1890, and 1900, to each succeeding year.

CHART NO. II.—DIPHTHERIA.
CHART NO. IV.—CROUP.
CHART NO. VI.—SCARLATINA.
CHART NO. VIII.—MEASLES.
CHART NO. X.—TUBERCULAR DISEASES.
CHART NO. XII.—PNEUMONIA.
CHART NO. XIV.—BRONCHITIS.
CHART NO. XVI.—TYPHOID FEVER.
CHART NO. XVIII.—DIARRHŒAL DISEASES OF CHILDREN.

CHART NO. I.—DIPHTHERIA.

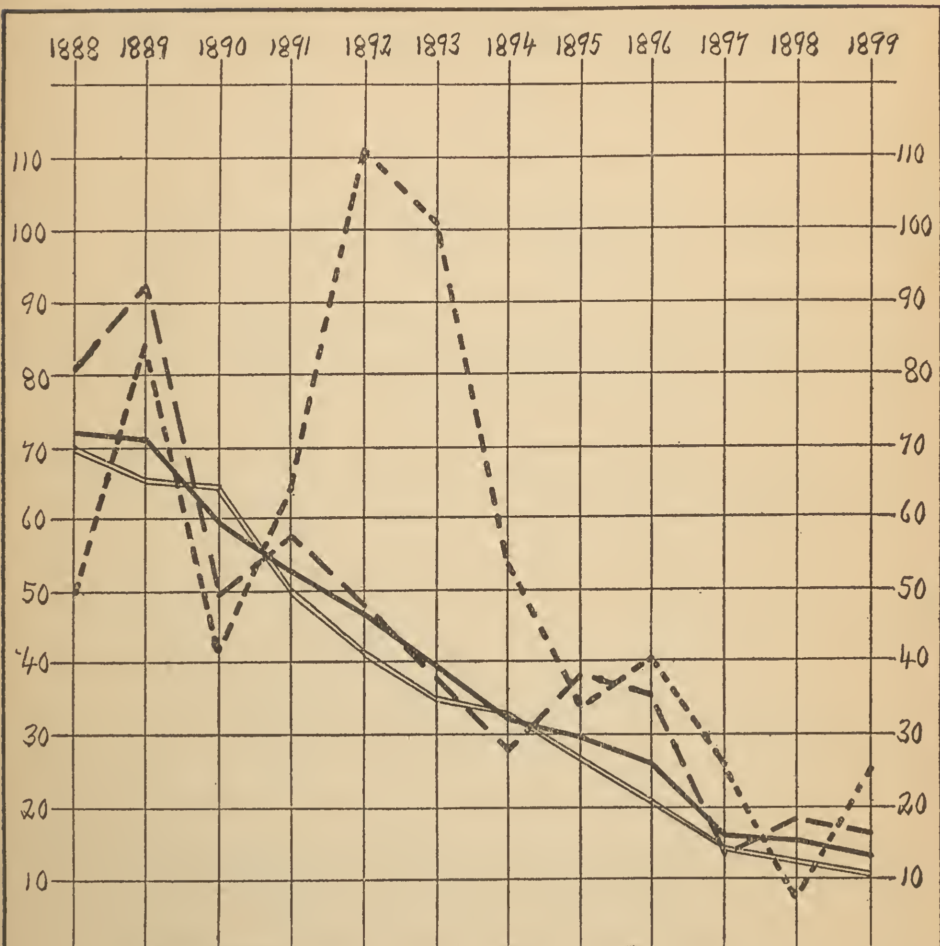
AVERAGE MONTHLY MORTALITIES FOR ELEVEN YEARS—1887-1897, INCLUSIVE.



The red line shows the average annual mortality from Diphtheria in Minnesota during the years 1898-1899. Antitoxine undoubtedly is responsible for this marked improvement over previous records. The death rate is still too high, however.

CHART NO. II.—DIPHTHERIA.

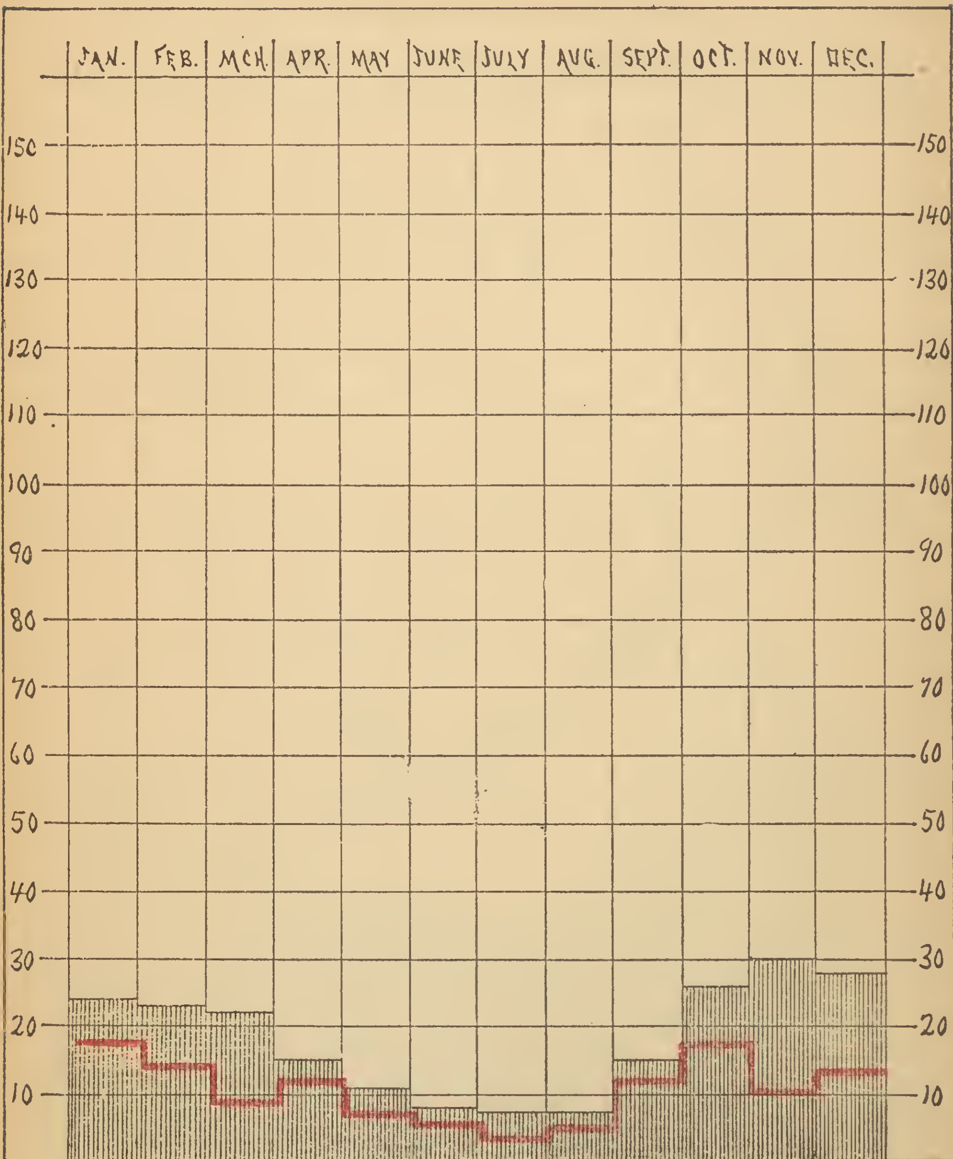
ANNUAL DEATH RATE PER 100,000.



It should be noted that while there has been a steady decline in the death rate from Diphtheria—taking the entire state, as well as in the state outside of cities having a population of 5,000 and upward—the decline is less marked in cities having a population of 15,000 and upward (which applies to only four cities), with an actual increase in cities having a population between 5,000 and 15,000. This would suggest improved methods of quarantine in the country, as also increased infection in small cities with imperfect quarantine.

CHART NO. III.—CROUP.

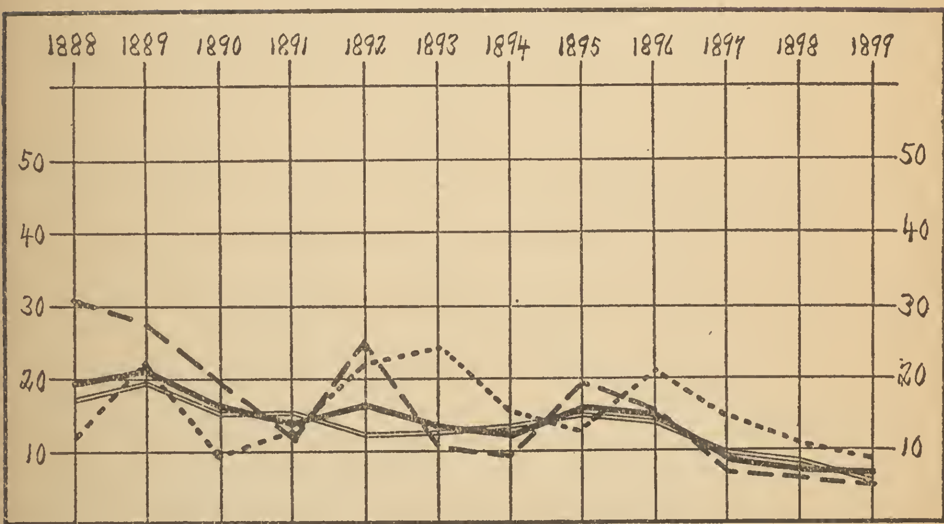
AVERAGE MONTHLY MORTALITIES FOR ELEVEN YEARS—1887-1897, INCLUSIVE.



The red line shows the average mortality from cases reported as Croup during the years of 1898-1899.

CHART NO. IV.—CROUP.

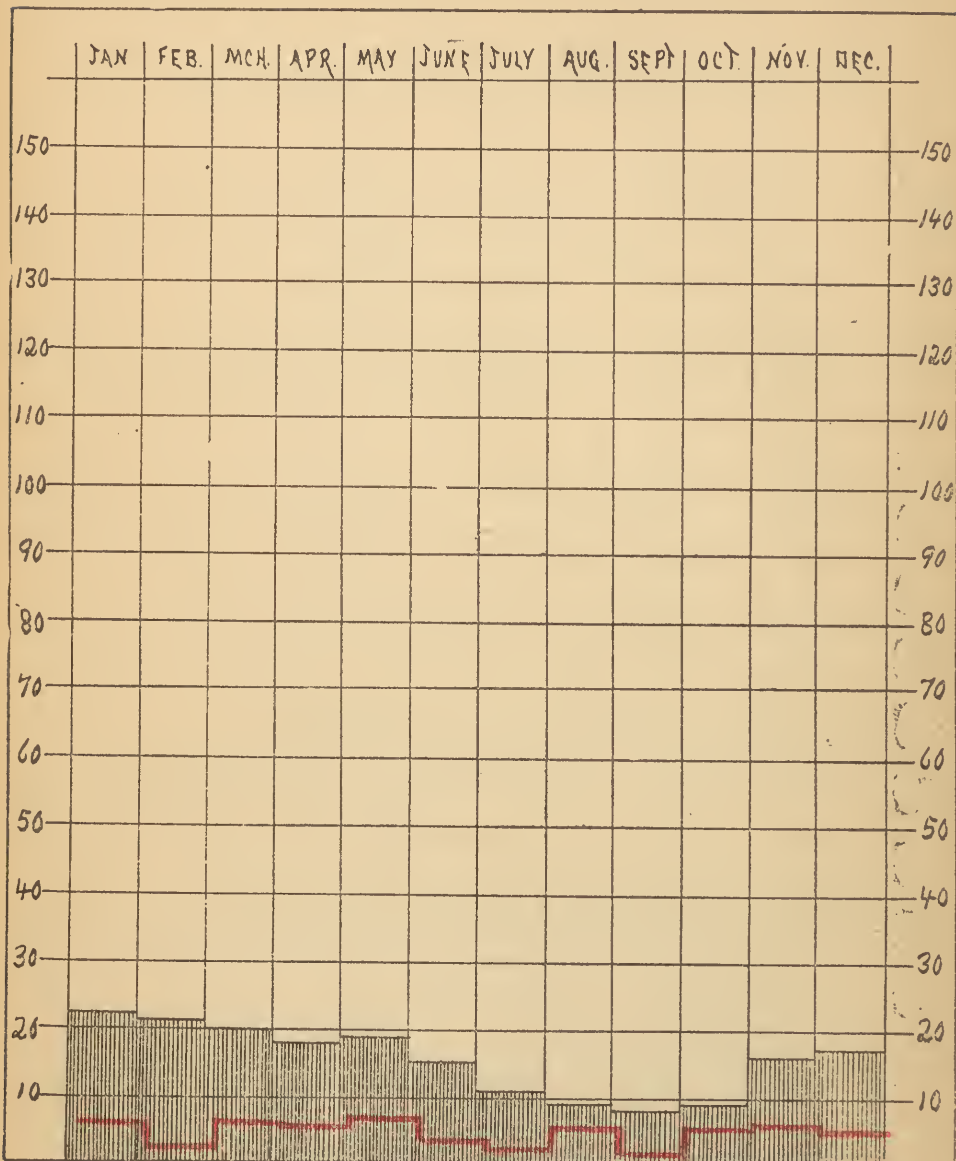
ANNUAL DEATH RATE PER 100,000.



The decrease in the number of deaths reported from "Croup" is due in part, undoubtedly, to the fact that many cases formerly reported under this name, are now reported under Diphtheria, where they properly belong.

CHART NO. V.—SCARLATINA.

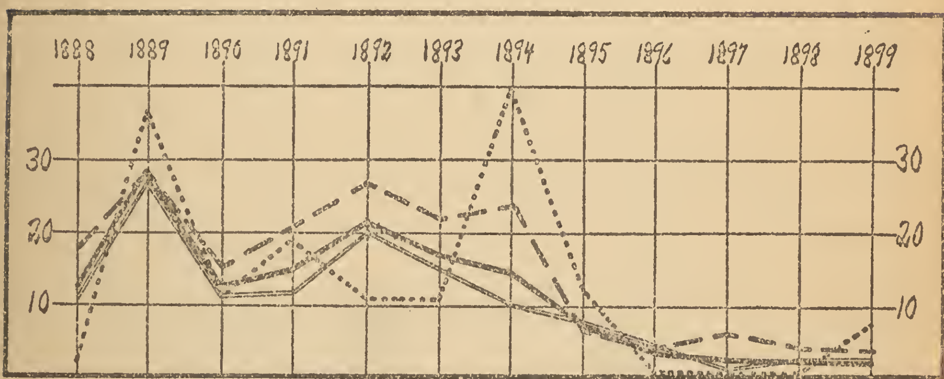
AVERAGE MONTHLY MORTALITIES FOR ELEVEN YEARS—1887-1897, INCLUSIVE.



The red line shows the average annual mortality from Scarlatina in Minnesota during the years 1898-1899. The mortality from this disease has been remarkably low in Minnesota since 1894.

CHART NO. VI.—SCARLATINA.

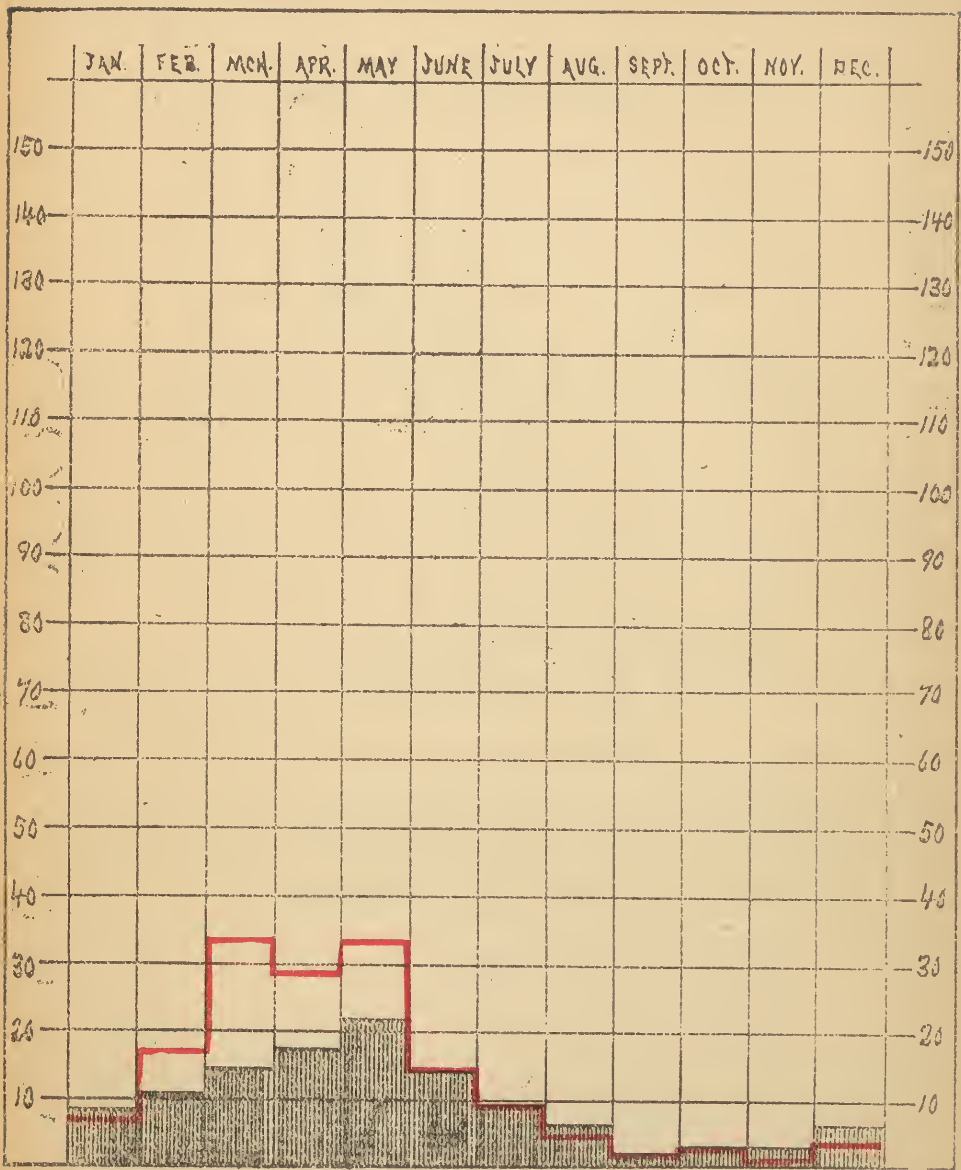
ANNUAL DEATH RATE PER 100,000.



It should be noted that while the rate of mortality from Scarlatina in the state at large, in the rural districts and in the larger cities, has been steadily on the decline, the mortality in cities and villages having a population of between 5,000 and 15,000, shows an increase in 1899. This is in all probability due, in part at least, to the less perfect quarantine methods pursued in some of these places as relating to this disease. The mildness of its type of late has been followed by an unwarranted indifference, too, in relation to its quarantine.

CHART NO. VII.—MEASLES.

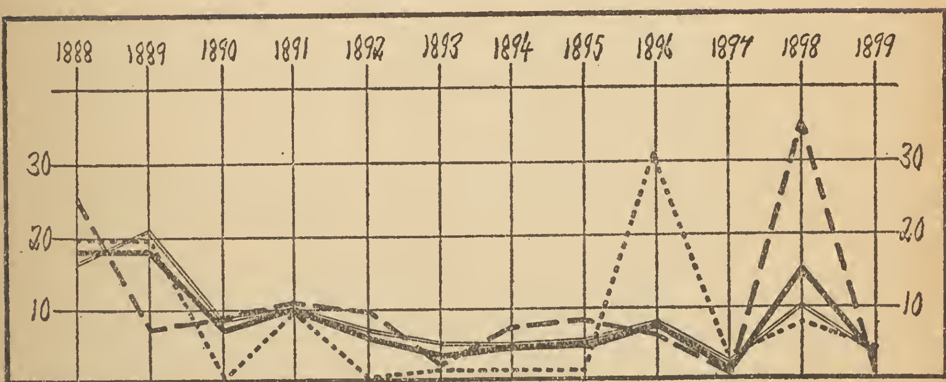
AVERAGE MONTHLY MORTALITIES FOR ELEVEN YEARS—1887-1897, INCLUSIVE.



The red line shows the average mortality from Measles in Minnesota during the years 1898-1899. It is noticeable that the mortality is greater than the general average for the preceding eleven years. Also that it is far above that of Scarlatina. The disease should be more carefully cared for.

CHART NO. VIII.—MEASLES.

ANNUAL DEATH RATE PER 100,000.



One cannot but realize from this chart that Measles is not so simple a disease as it is generally supposed to be. People should place more responsibility upon the medical profession in its care than they now do.

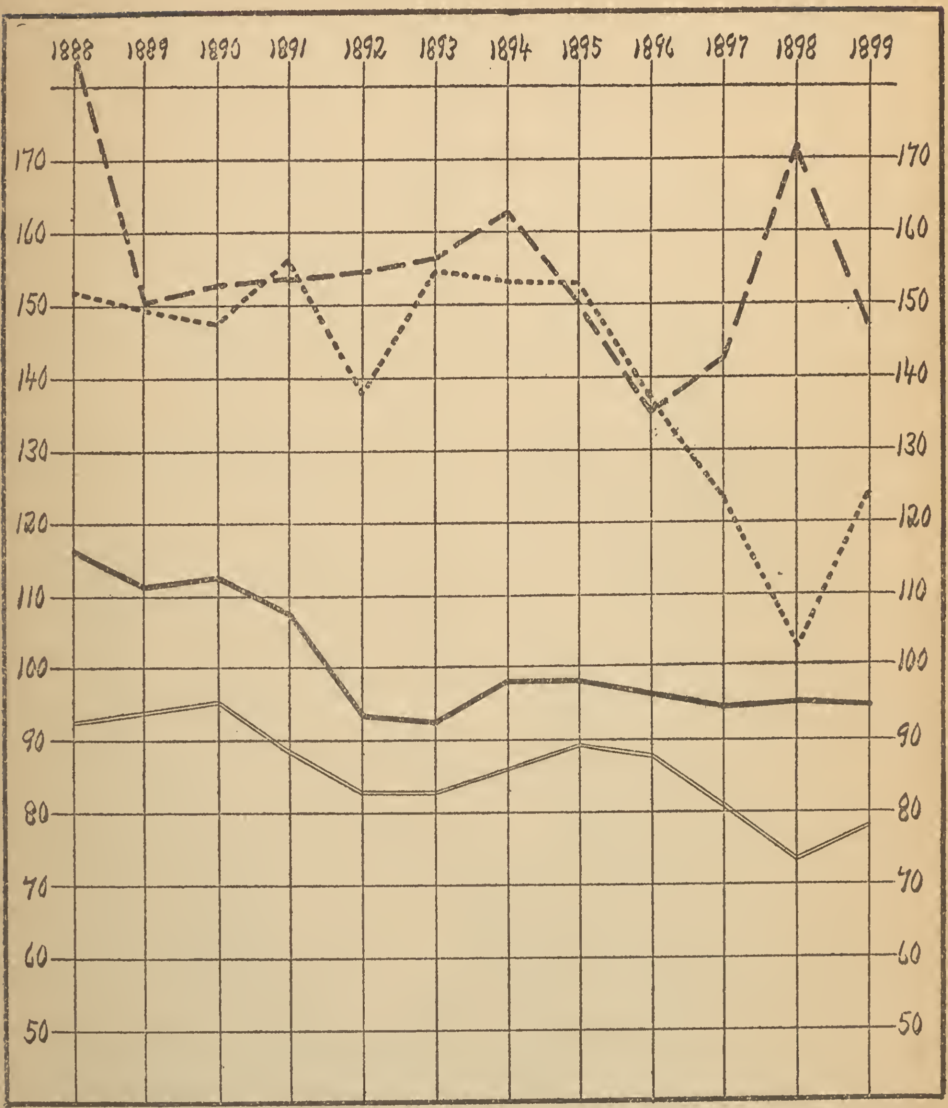
CHART NO. IX.—TUBERCULAR DISEASES.

AVERAGE MONTHLY MORTALITIES FOR ELEVEN YEARS—1887-1897, INCLUSIVE.

The red line shows the average annual mortality from Tuberculosis in Minnesota during the years 1898-1899. It is unfortunate that with our increased knowledge as to the nature and control of this disease, there should be such a marked increase in the mortality rate over that of preceding eleven years average.

CHART NO. X.—TUBERCULAR DISEASES.

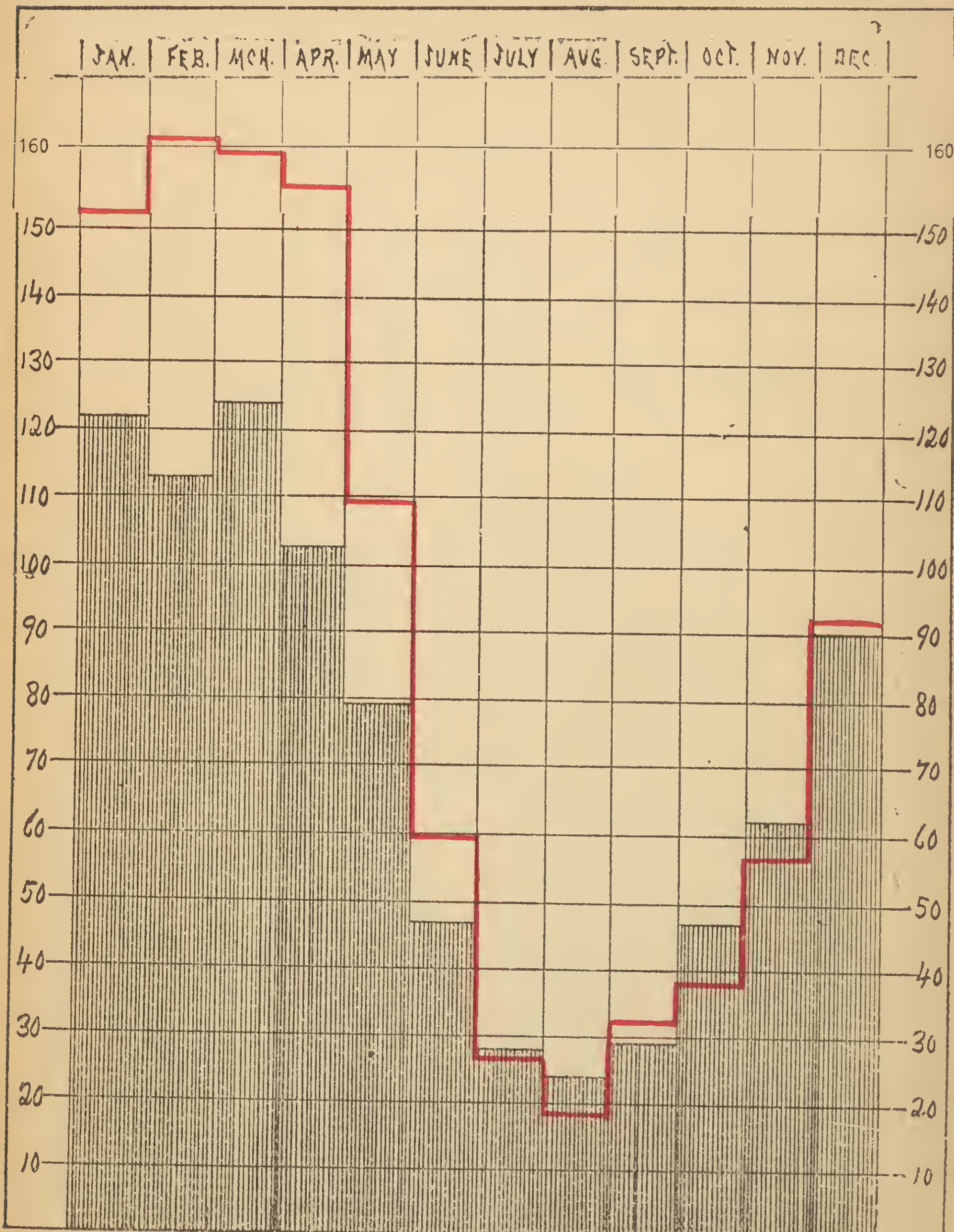
ANNUAL DEATH RATE PER 100,000.



This chart is not a very encouraging one. It needs no further comment than to call for a comparison with the diagram on page 150.

CHART NO. XI.—PNEUMONIA.

AVERAGE MONTHLY MORTALITIES FOR ELEVEN YEARS—1887-1897, INCLUSIVE.



The red line shows the average annual mortality from Pneumonia in Minnesota during the years 1898-1899. The marked increase during the first four months of the year is striking. The significance of this increase may be slight, the conditions depending upon temporary atmospheric conditions.

CHART NO. XII.—PNEUMONIA.

ANNUAL DEATH RATE PER 100,000.

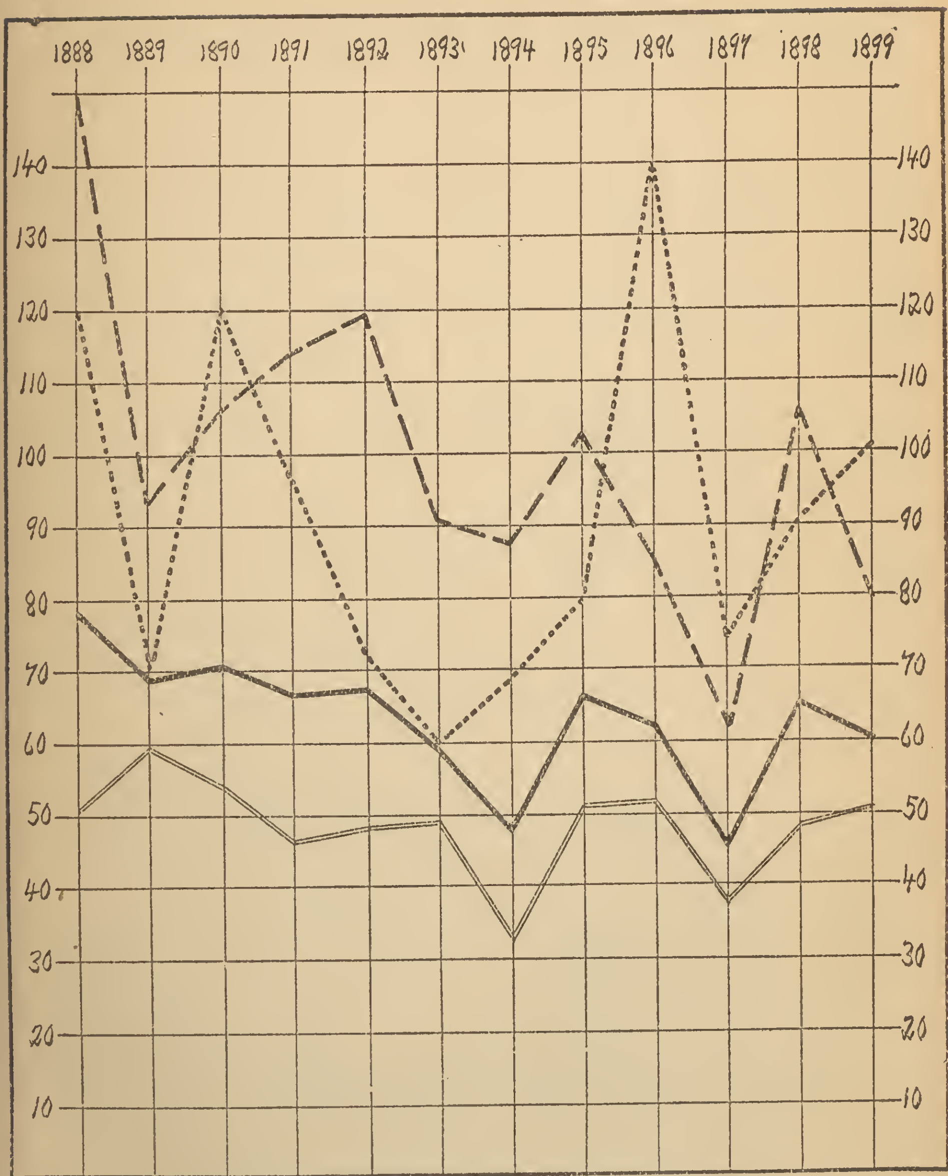
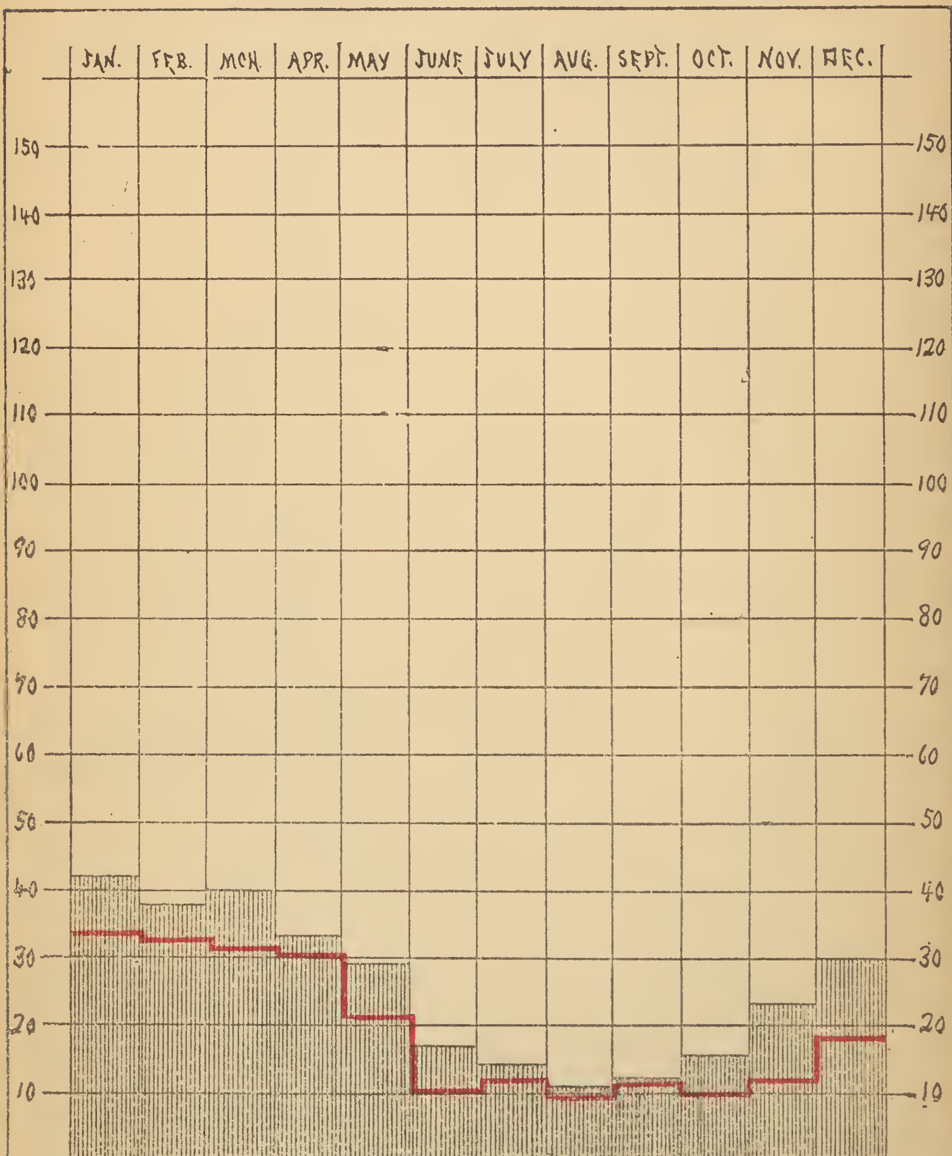


CHART NO. XIII.—BRONCHITIS.

AVERAGE MONTHLY MORTALITIES FOR ELEVEN YEARS—1887-1897, INCLUSIVE.



The red line shows the average annual mortality from Bronchitis in Minnesota during the years 1898-1899. It is pleasing to note a decline over the average of the preceding eleven years.

CHART NO. XIV.—BRONCHITIS.

ANNUAL DEATH RATE PER 100,000.

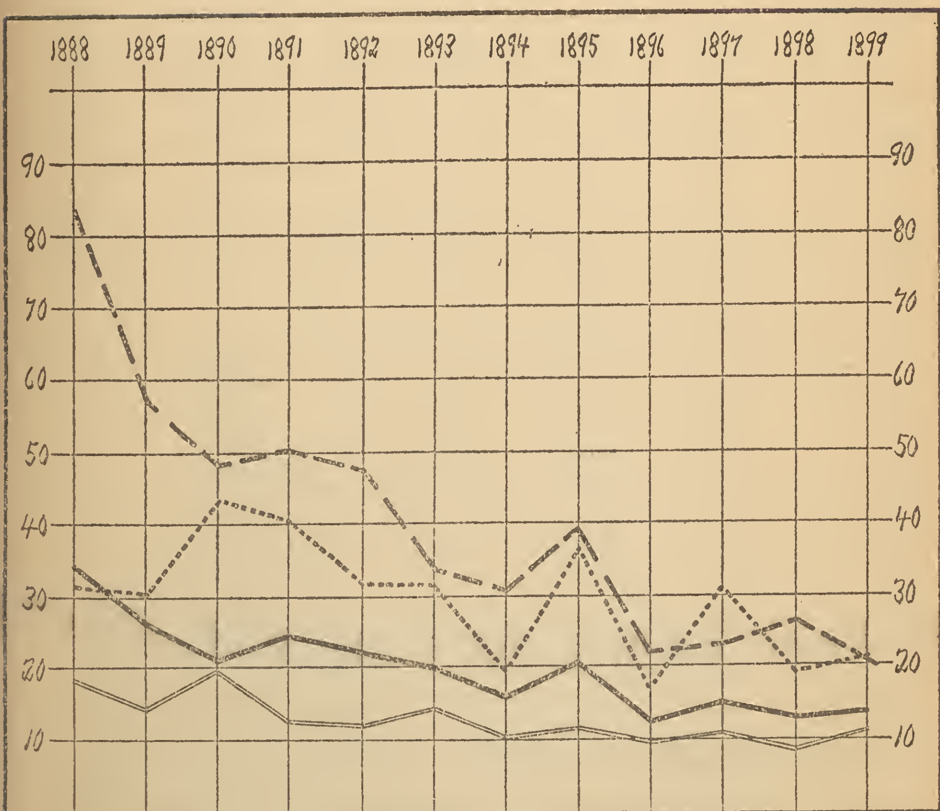
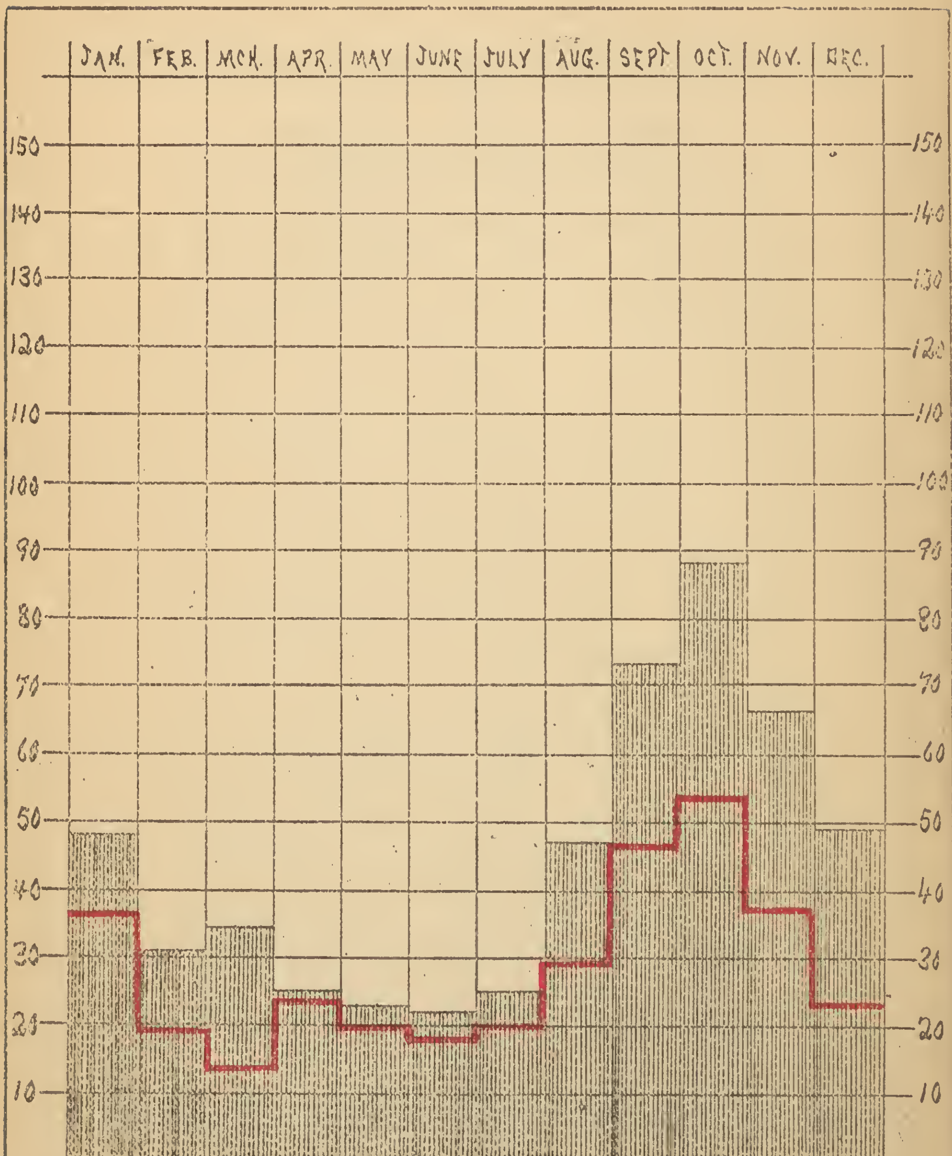


CHART NO. XV.—TYPHOID FEVER.

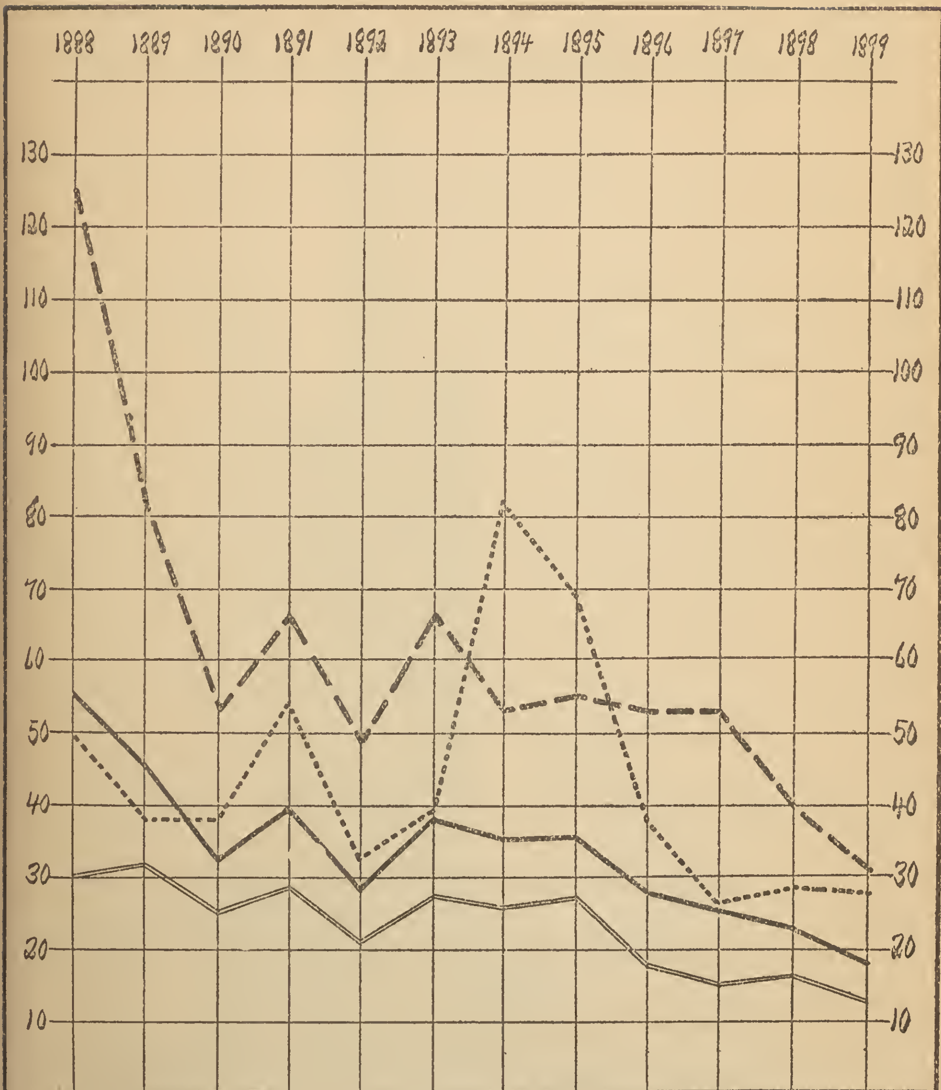
AVERAGE MONTHLY MORTALITIES FOR ELEVEN YEARS—1887-1897, INCLUSIVE.



The red line shows the average annual mortality from Typhoid Fever in Minnesota during the years 1898-1899. It is pleasing to note the fact that it is below that of the preceding eleven years, It is entirely too high yet, however.

CHART XVI.—TYPHOID FEVER.

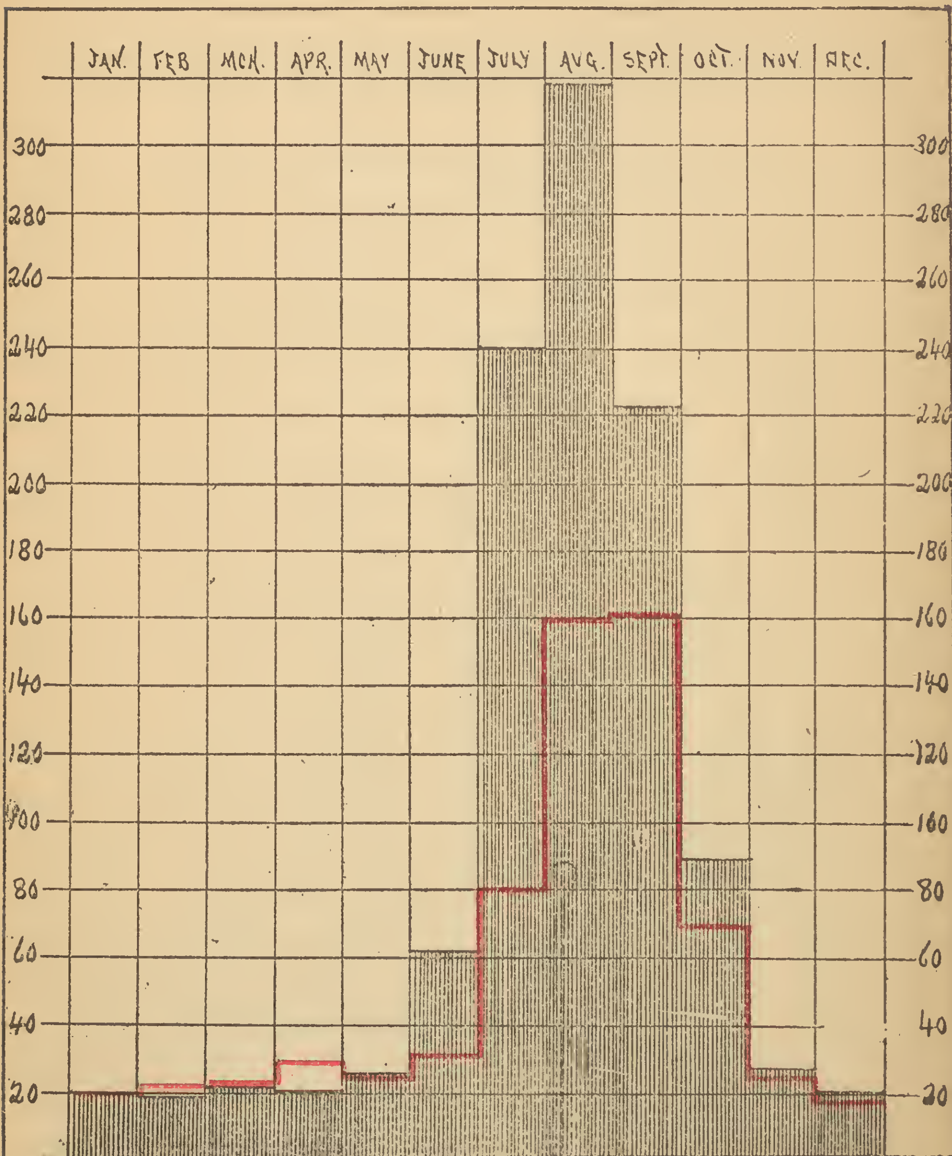
ANNUAL DEATH RATE PER 100,000.



While the general trend of mortality from Typhoid Fever in Minnesota is downward, it is worthy of note that in places having a population ranging from 5,000 to 15,000, there has been no reduction since 1897. In fact, there has been rather a slight increase. This is what we should expect in places of this size as they grow older, and continue to have imperfect water and ice supplies.

CHART NO. XVII.—DIARRHŒAL DISEASES OF CHILDREN.

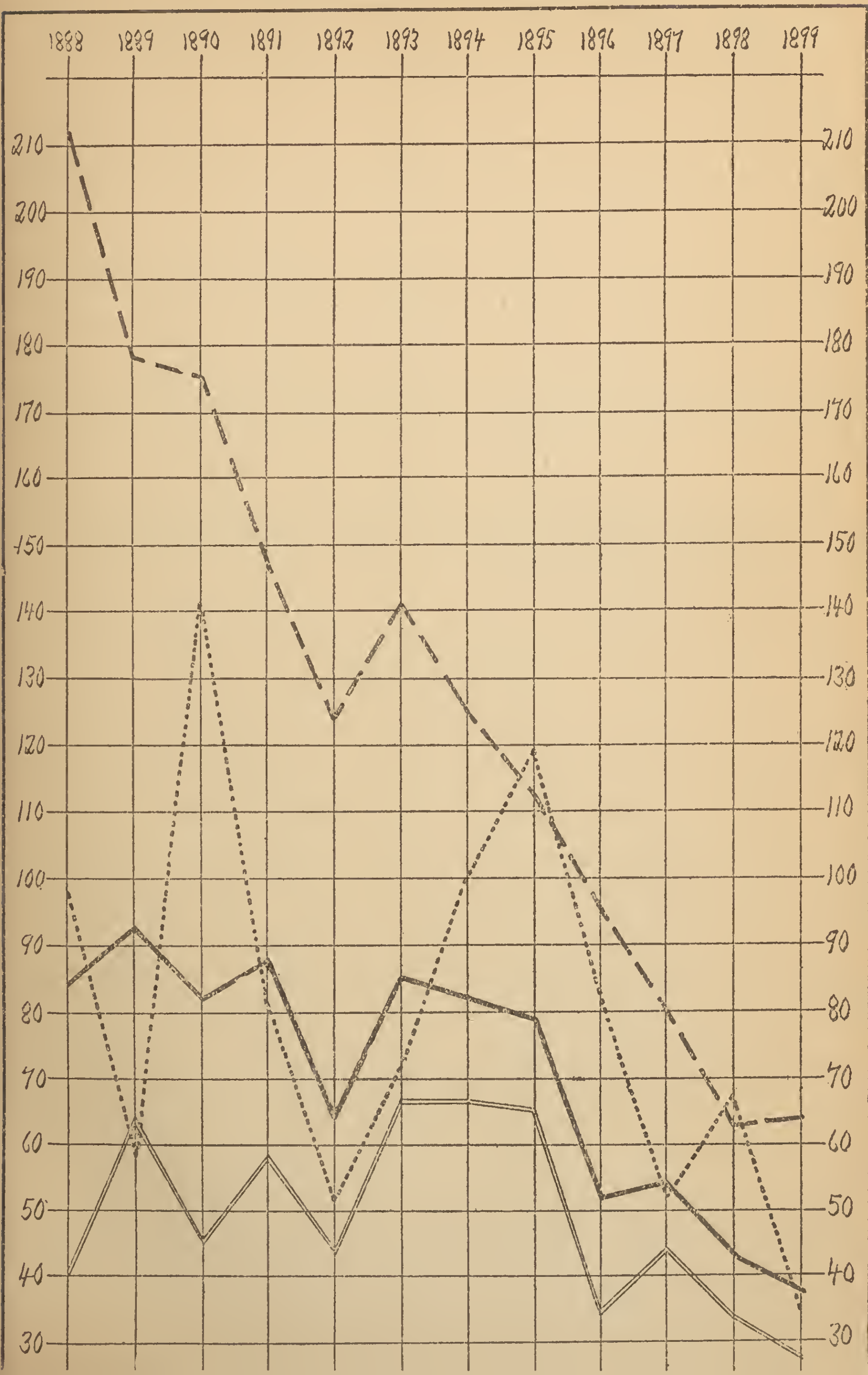
AVERAGE MONTHLY MORTALITIES FOR ELEVEN YEARS—1887-1897, INCLUSIVE.



The red line shows the average annual mortality from Diarrhœal diseases of children in Minnesota during the years 1898-1899. It is pleasing to note the decided fall from the average of the preceding eleven years during the summer season.

CHART NO. XVIII.—DIARRHŒAL DISEASES OF CHILDREN.

ANNUAL DEATH RATE PER 100,000.



REPORT OF THE CHEMIST.

1899-1900.

11

Minneapolis, Minn., Oct. 7, 1900.

Dr. H. M. Bracken, Secretary State Board of Health, St. Paul, Minn.

Sir: I have the honor herewith to transmit a report on the work of the water survey and the chemical laboratory up to date. It includes chiefly the results of some five months' field work in southern and southwestern Minnesota, supplemented by analyses carried on in the laboratory.

Respectfully,

HUBERT CAREL,
Chemist.

REPORT OF THE WATER SURVEY.

The primary objective of this survey was the determination of the natural chlorine in Minnesota waters and the subsequent preparation of an isochlor map.

In uninhabited districts this, of course, could easily be accomplished by testing for that element only, but in centers of population where the chlorine of numberless waters represents, not the natural salt, but rather the salt of sewage infiltration, it is necessary to supplement the single silver test with further sanitary analysis.

Consequently the majority of samples thus far have been given a qualitative test for nitrous and nitric acids and a quantitative determination of organic matter as evidenced by the reduction of potassium permanganate.

In addition, the determination of alkalinity was often made, and occasionally hardness, as evidencing the inorganic relationship or dissimilarity of certain waters.

In a number of instances even the above tests were not considered sufficient, and during the eight weeks of the summer of 1899 we requested local health officers to send certain samples to the laboratory for the ammonia determination.

As a rule, this was not done, and in the summer of 1900 we attended to such shipping ourselves, and followed the samples to the laboratory. This necessitated the expenditure of considerable money in traveling expenses, which to some extent was neutralized by the saving in hotel hotel bills while in the city.

Moreover, such return was of further advantage in permitting the analyses of specimens sent in by health officers from other parts of the state, which otherwise could not have been examined during the summer. These specimens were kept constantly in a refrigerator until examined, which usually was not longer than a week.

On July 26, 1899, the chemical survey was started. Taking the town of Luverne, in Rock county, the extreme southwest of Minnesota as a starting point, we began to work the southern tier of counties. As our appropriation allowed only for hotel bills and railroad passage, we were largely restricted to working along the Omaha and Milwaukee roads, which fortunately passed east and west across the lowest tier of counties. Our primary idea was to

stop at stations some thirty miles apart, and if the analyses were similar to go on, or if differences were noticeable to work back again.

However, the number of polluted town supplies made it imperative that we proceed more slowly and include at least all large communities on the east and west railroads and south branching lines. We made no endeavor to reach points to the north of this route.

In Houston and eastern Winona counties, however, the unusual variation of the chlorine in organically pure waters compelled a long stop and considerable team work. Fortunately we secured a very low hotel rate at Houston village (five dollars per week), which set free some funds for the livery. The western half of Winona county, likewise Olmsted and Dodge, were hurried through, merely taking samples as we passed on the Northwestern road. We made no north or south detours, save at St. Charles, hence those districts were to be completed in the second year. In passing, we also included when possible some inspection of sewage disposal and ice supplies.

The second summer we were in the field three months. A longer stay could have been made, but funds were exhausted. The small appropriation usual for new work constrained us to closely economize at the expense of rapidity. We were helped considerably, however, by the rate concessions granted us by many local hotel men. The previous summer had demonstrated the necessity of going over the ground slowly and carefully, else we might easily pass entirely by some salt districts. The one about Houston village has a radius of not more than seven miles.

It was out of the question to do the work thoroughly without more or less driving, and this required considerable outlay of money. A good team as part of our outfit would have been of great value, and I hope another year may supply sufficient funds to purchase and keep one.

The conditions prevailing in many towns had evidenced the great need of personal inspection as to municipal ice and water supplies. Consequently we began the season with the plural objects of determining the chlorine and examining the public water and ice supplies, as well as the general sanitary conditions.

In our estimation of the public waters we considered, first, the environment, and if that were satisfactory the chemical tests above mentioned were made. If the water passed both inspections, we considered it good. In case of the slightest suspicion, however, we sent a sample to the laboratory for the ammonia test as an additional safeguard. In same cases a second analysis was deemed advisable, to determine the constancy or variation of some elements, particu-

larly chlorine. In such comparisons any variation would point to sewage pollution.

The previous summer's work had effectually demonstrated the utter futility of examining shallow wells as a means of determining the normal chlorine. It is extremely difficult to secure unpolluted surface water in an inhabitated district. The great number of vaults, barns, cesspools, etc., in both town and country, and especially their almost inevitable "handy" proximity to the water supply, effectually barred the shallow well from our work, save in the case of a public supply.

These conditions rendered the collection of samples of apparent purity difficult, by reason of their scarcity, often an entire day's drive bringing in but a few specimens, and of these some were sure to be worthless, even though we confined ourselves to deep wells, flowing wells, springs, creeks and lakes.

The prevailing idea that 100 feet more or less of clay or rock is sure protection against organic infiltration, likewise that a down slope from well to vault is similar security, are too often illusions. Clay has its rifts of sand, which, pipe-like, carry pollution; likewise many ledges of rock are seamed with small interstices or cracks, permitting the passage of noxious matter. Again, a statement is often made that some certain well is drilled or driven to many feet; but the water often comes from but a shallow depth,—from some surface flow,—and sometimes, moreover, the well has, in truth, been drilled to a great depth, but subsequently filled up. Data of this nature are usually omitted, and merely the original full depth given. This may account for the chemical evidence of pollution in some reputed deep wells. Finally, in many of the older communities the practice of covering over ancient vaults and removing the superstructure to a new hole in the ground accounts for another phase of occular purity but chemical condemnation.

Such facts go to prove that, while personal inspection is highly important, it cannot be relied upon in the absence of chemical examination. Too many "best waters in the country" are subject to infiltration of filth. The people, however, often continue to drink these waters even after a chemical demonstration of their impurity. Subsequent physical indispositions are rarely laid to the true source, a dirty drinking water.

If chemical analysis of water has any value, then sources of water supply condemned by analysis should be closed to the public. But our function is entirely advisory, and unfortunately that advice too often entails the kind of work which meets the opposition of certain interested citizens, and consequently is not carried out by the local health department. It is practically out of the question to ex-

pect a local physician to make needed sanitary improvements in the face of powerful local opposition.

It would have been a useless task for us to revisit towns in order to learn the results of our advisement, and consequently we are not in position to state whether or not necessary sanitation was enforced. To be sure, we often succeeded in securing promises, but some of these promises we afterwards learned were unfulfilled, and the polluted supplies are in continued use despite our protest.

The second summer's work was taken up at last year's point of leaving. Starting with Winona and Lake counties we worked the second tier of counties across the state to Pipestone. Going north, and starting again to cross the state, we were stopped in Lyon county by a high chlorine district. Following this in all directions we found that it was much more extensive apparently than the Houston-Winona salt area. Its northern and northeastern limits are yet to be determined.

During the survey 923 samples were collected, analyzed and recorded. Of these 354 were considered either suspicious or condemnable, and 569 passed as water available for the chlorine normal. Of the condemned and suspicious waters sixty-three were supplies from public drinking places. Among the analyses seventy-eight were springs, forty-eight were streams, twenty-two were lakes, 177 were flowing artesians, 313 were common artesians, 204 were surface wells, and fourteen were melted ice or sources of ice supply.

This survey has demonstrated the absolute necessity of determining the salt normal. The occurrence of high chlorine in organically pure waters was not considered probable outside of the Red River Valley region, and we have yet to finally account for its occurrence in Houston, Winona, Lake, Scott, Lyon, Yellow Medicine, and Lac qui Parle counties, and yet to discover it in other parts of the state.

Any one of the many fine flowing wells in salt districts would have been unalterably condemned by chemists not familiar with the saline conditions there prevailing.

Hereafter the quantity of sodium chloride normally present in Minnesota waters will be an absolutely unknown factor save only as determined by water surveys throughout the state.

Another point worth mentioning is the fact, demonstrated by this work, that the permanganate method of testing for organic matter needs considerable experimental study before its dictum can be relied upon. We have noticed, especially in our best lakes and streams, a very large amount of oxidizable matter, due, inferentially, to vegetable growths. According to the accepted standard of purity as measured by this test, hardly a lake or stream in Minnesota would pass as a good water. In the same way I have noticed

in the ammonia determination that often an apparently excellent lake water would yield a condemning quantity, due presumably to the same vegetation. All of which evidences the advisability of personal inspection to supplement chemical analysis in determining as to the quality of any water supply.

I may repeat in passing that the people of southern Minnesota seemed universally to highly appreciate the work of the state board of health in initiating a state water inspection, and afforded every facility within their power for its advancement.

REPORT BY COUNTIES.*

ROCK COUNTY.

Luverne—The village supply consists of a surface well, twenty feet deep, in loam, sand and gravel, situated 150 feet from the Rock river, in a large park opposite the town. There was one source of contamination in evidence, consisting of the closet for the use of the waterworks men and the people who came to the park. This was some nineteen paces from the well, and the chemical analysis showed the inevitable pollution (No. 1).

We advised the local board of health to clean out this closet, disinfect with lime, and build a cemented vault, at least 400 feet from the well. We requested another sample when this was done. Said sample has not yet been received, hence the inference is that the conditions remain the same and that our time and labor have so far been spent in vain.†

Spring freshets of the Rock river, carrying the usual detritus, sometimes overflow the top of this well. We advised the building of protective masonry. Said Rock river, at Luverne, has an average depth of three feet and a width of thirty. It is a sluggish stream in summer, but often a violent flood in spring. It undoubtedly passes some dirty farms on its way, as evidenced by the nitrates and nitrites shown in its analysis (No. 2).

Luverne has no sewage system as yet, but will probably pollute this stream still more when such system is put in, as it is the rule in Minnesota villages and cities to make open sewers of all water courses, notwithstanding the state law to the contrary.

Seventeen other surface wells were examined in Luverne, including the one at the courthouse and at the Burlington depot. All

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*The numbers throughout this report refer to samples taken for field analyses (F. A.) unless otherwise specified.

†Since writing the above we have received notice that the closet has been removed.

of these were more or less contaminated (Nos. 3 to 18 inclusive and No. 40).

The town lies in the valley of the Rock river and its drainage flows in one direction. The private water supplies are all shallow wells, dug in sand and gravel and an occasional stratum of clay. The numerous outhouses are in the same stratum, and the combination of sewage and surface water flows through the town at a depth of about thirty feet, being tapped here and there for drinking purposes. We notified the local board of health as to the prevailing conditions, and requested further samples, which have not been sent. Luverne's ice supply is cut from the Rock river, above the town. A sample of this should be examined.

Hardwick— On the road to Hardwick, and in the village itself, ten samples were collected, including several springs, two flowing artesian and some shallow wells (Nos. 19 to 25 and 36 to 38). There is no public water supply and no sewer. Among the best wells were a flowing artesian, drilled to 150 feet, with a capacity of 300 gallons per minute (No. 24), and one on higher ground, drilled 110 feet (No. 25). Both of these wells passed through loam, red clay, blue clay and gravel; no rock. They are fair samples of the deep water of the county. Samples were taken from two excellent type springs (Nos. 36 and 37). No. 35 is a fair sample from a spring-fed creek.

Beaver Creek—The village water (Nos. 26 to 31) was generally contaminated. Samples were taken from the depot well and the hotel well, both of which gave an abnormal reaction. This creek itself gave a fair sample. No. 33 was from a bored well, 160 feet deep, through solid rock. A barn was located eighty feet distant, on the up slope. The presence of nitrites in this water would indicate a crevice in the rock. No. 34 was taken from what is locally well known as the "Mounds Spring." It is removed from any apparent pollution, and is presumably a good water. No. 39 was taken from the deepest well in the county. It was stated to be 358 feet in depth, through loam, clay and rock.

NOBLES COUNTY.

Adrian—The village supply (No. 42) forms an exception to the usual conditions of surface water. It is from a dug well forty-seven feet deep and twelve feet wide, with stone curbing, and yields at present a fairly good analysis. All such waters are, however, subject to possible pollution in the future, as houses encroach nearer. Consequently we advised the local board of health that the village should purchase the two contiguous lots, at present vacant, and

make of them a small park. Such a course would materially help to preserve the present purity of the water. We further advised watching the condition of the supply by an occasional analysis.

Sample No. 42 was taken from a driven well three miles north of Adrian, ninety feet deep, through loam, yellow clay (four feet), blue clay (ten feet) and sand. No. 43 was taken from a dug well in the same neighborhood, with a barn fifty feet distant on the level. No. 44, taken eight and a half miles north of Adrian, was from a driven well, twenty-five feet deep, in clay and sand, with barns, etc., within fifty feet. No. 45, seven and a half miles north of Adrian, was from a similar well. Nos. 46 and 47 were from shallow wells, but the latter was near to contamination. Nos. 48 and 49 were both from driven wells, in clay and sand. No. 48, however, was environed by a pig yard, while No. 49 was without apparent contamination, and contained considerable iron. Nos. 50 and 51 were taken from two springs, in the fields, some two miles west of Adrian. They yielded the lowest chlorine thus far found in Nobles county. Adrian has no sewerage system. No. 66 is from the Kanaranzi river, a shallow stream, some ten to fifty feet broad, which floods in spring time. A second sample, taken from it and sent in by Dr. Sullivan, confirmed our previous opinion as to probable pollution (Lab. Anal. No. 540). This stream furnishes the ice supply for Adrian, and its contamination is due largely, possibly wholly, to a barnyard half a mile above, which reaches to the bank of the stream itself. This pollution is entirely beyond the jurisdiction of the health officer, and cannot be controlled. Such conditions evidenced the need of a state inspector, with authority to regulate such abuses, and stop the pollution of village water supplies.

Worthington—The public supply was rather an unusual mixture. Originally the water came entirely from an artesian well, seventy-five feet deep, which yielded sufficient water for the village. Later, in order to supply the railroad company, two great trenches were dug in the sand, one lying to the right, the other to the left of the artesian well, and along the shore of Lake Okabena. These trenches were some 100 feet long and fifteen feet deep. They were tiled at the bottom, and filled with sand and gravel. The water collecting on the tiling ran into a reservoir in common with that from the artesian well. These two trench wells were in direct line to receive the city drainage as it flowed towards the lake. Chemical analysis evidenced contamination of both surface wells and a high degree of purity for the artesian. The mayor of the city ordered both surface supplies closed. No. 52 is from the mixed supply, which we were informed was artesian water. The analysis, however, evidenced otherwise. We finally learned the true conditions, and examined each source separately. Worthington sewage empties

into a slough one-half mile from the village limits, a condition which will in time become a nuisance.

No. 85, taken six miles south of Jackson, was from a driven well sixty feet deep, in sand and clay. No. 86 was from a bored well, 285 feet deep, likewise in sand and clay, and located at the side of a pasture, about a mile from where the previous sample was taken. Nos. 88 and 89 were taken from fairly deep wells, in the yellow and blue clay. They were evidently subject to some infiltration from pollution, which was within thirty feet in both instances. No. 90 was "suspicious," from its nitrites, but it yielded a low chlorine. None of the wells taken pass through any rock.

MARTIN COUNTY.

Sherburn—This village is supplied by an artesian well, 200 feet deep, with satisfactory analysis and environment (No. 99). The Sherburn sewer empties into Temperance lake. Nos. 92, 93, 95 to 97 represent chiefly shallow wells, which were not considered pure by evidence either of environment or analysis. No. 94 is from a well, bored in hardpan, and well located. Its data may be considered typical.

Fox lake is about a mile wide and five miles long. The environment is nature's wilderness, and its water represents a fair lake type (No. 98). The high consumed oxygen is apparently due to vegetable matter, a feature common to many of our lakes and streams.

Fairmont—This village is located on Sisseton lake, which is one of a chain of lakes running along the western edge of Westford, Rutland, Fairmont and Silver Lake townships, thence into Iowa. The entire chain is drained by Elm or Chain creek. The village water is taken from Budd lake, just without the town. The analysis of its water is represented by No. 100. This lake is directly connected, by a short steamboat channel, with Lake Sisseton, into which it slowly drains, and from which sample No. 101 was taken. The shore and shallows of said Lake Sisseton have been used as a dumping ground for stable and other refuse. Quantities of organic matter have been dumped directly into the shallow water, and undoubtedly affect Lake Budd, particularly in seasons of heavy rainfall or strong winds, when, according to local authorities, Lake Sisseton backs up into Budd lake. We recommended cleaning up the manure from Sisseton and the prohibition of further dumping upon its banks. Fairmont ice is cut from Lake Budd. The town has no sewer system. Since the above was written samples from both Lakes Budd and Sisseton have been examined in the laboratory (Lab. Anal. Nos. 516 and 517).

Nos. 103, 108 and 112 are from the usual shallow, contaminated well waters. Nos. 102, 104, 107, 109, 111, 113, 114 and 116 may be considered as fair specimens of the deeper Fairmont wells, ranging from sixty to 140 feet, and passing through clay and gravel. No. 105 is an example of a good surface water. No. 106 was taken from a well two miles north of Fairmont, and designated as a "deep" well, but no particular depth known. The barn was twenty-five feet distant. Nos. 110 and 115 were both from wells located near outhouses. Bullard's hotel well (No. 117), which supplies the traveling public, is 100 feet from the hotel cesspool, and should be closed.

According to the local health officer, it is difficult to make any excavation in older Fairmont without digging into an ancient vault. Such conditions evidently render it difficult to secure good surface water. (For other examination of Fairmont waters, see Lab. Anal., 516 to 520.)

FARIBAULT COUNTY.

Winnebago City—The water supply is obtained from a chemically pure artesian well, which passes through loam, blue and yellow clay to 260 feet, then six feet of rock. Water is pumped into a tiled cistern, kept clean. It is represented by No. 118. Winnebago has no sewage system. Its ice supply is now cut from the Blue Earth river, which evidences some form of contamination, as shown by No. 119. Nos. 120 and 121 are from shallow flowing wells fifty and twenty feet deep. Nos. 122, 123, 125 to 128 are from contaminated wells. No. 124 is a fair sample of the natural deep well water, and No. 129 of natural spring water.

Blue Earth City—This place was hurriedly visited. The village water supply, represented by sample No. 130, is of excellent quality, coming from a depth of 1,240 feet. The well was at first drilled to 1,400 feet, but the water at that depth was very salty, hence the well was partially filled up. The following is the geological stratification of the wells:

Loam	3 feet
Yellow clay	58 feet
Sand and quicksand	40 feet
Blue clay	25 feet
White sand	69 feet
Gravel	5 feet
Drift rock	2 feet
Upper Trenton	80 feet
Igneous rock	2 feet
St. Peter sandstone	91 feet
Shakopee limestone	215 feet
Jordan limestone	80 feet
Lawrence sandstone	170 feet
Dresbach	65 feet
St. Croix shales	115 feet
St. Croix red shales	175 feet
Lower St. Croix sandstone	175 feet
Copper ore	1-2 inch
Granite	20 feet
Total	1,240 feet

Nos. 132 to 134 were taken from the usual polluted shallow wells. No. 135 gives a fair sample of the average deep well water.

Wells—The village supply, represented by No. 136, is from an excellent flowing well, sunk through loam, blue clay and rock. The water fills an eight-inch pipe with a constant flow. No. 137 was taken from the Milwaukee railroad well, 114 feet deep, through loam three feet, yellow clay eighty-five feet, blue clay twenty feet, rock one foot, to white sand.

Nos. 138, 139, 141 were all taken from fine flowing wells. Nos. 140 and 143 were from formerly flowing wells also. No. 142 was from the dirty slough water, derived from flowing wells but polluted by sewage. It was examined by request of Dr. Leland, the health officer.

The disposal of sewage is an unsolved problem as yet for Wells. There is a small creek formed by flowing artesian wells, into which the present limited sewage flows. However this creek is so small (some three inches deep by eighteen inches broad) that its water, by analysis, is highly polluted, and a menace to the community.

FREEBORN COUNTY.

Alden—The village well, represented by No. 145, is a chemically good artesian, 100 feet deep, and passing through fifty feet of rock. No. 147 was taken from a good street well, considerably used. Nos. 148 and 149 were taken from the typical shallow wells, subject to inevitable pollution. No. 150 was taken from an artificial lake, from which ice is cut.

Albert Lea—The city water supply is from a fine flowing artesian well, 650 feet deep, in drift, gray shale and limestone, represented by No. 592. The ice supply is taken from Fountain lake, the quality of whose water is represented by Nos. 158 and 159. This body of water was formerly much smaller than it now is, the present size being due to the construction of a dam, which separates it from Albert Lea lake. For the past forty years Fountain lake has been used as a dumping ground for all kinds of refuse from the city. Owners of abutting property commonly cart all stable and other refuse to the lake. In one instance, an artificial bank to the height of some fifteen feet has been constructed of manure. In addition to this, à drain carrying kitchen (?) refuse and street washings flows into the lake, and periodically the cesspool of a young ladies' seminary overflows into the lake. The water, being held back by the dam, has thus an excellent chance to contaminate itself. Accoraing to one of the city physicians, there were two cases of typhoid fever directly traceable to the ice.

We recommended closing the drain, supervision of the cesspool, cleaning up of the manure, strict prohibition of all future dumping. The sewage of Albert Lea passes chiefly into Albert Lea lake. (For laboratory analysis of the lake water, see No. 543.) No. 152 was taken from the old city well, which is still used. It gave a very low consumed oxygen test.

Nos. 154, 162, 164, 166 and 167 were taken from dirty, shallow wells. No. 163 was taken from the kitchen (?) drain, which runs into Fountain lake. It gave a typical old sewage analysis. No. 153 was taken from a tubular well, of unstated depth, with an outhouse twenty feet and barn fifty feet distant. No. 156 was from a flowing artesian, coming up at the foot of a sharp slope of the ground, with a manure pile ten feet distant and a chicken yard up to the well. All of this probably accounts for the trace of nitrites. No. 155 represents a fair sample of the nonflowing drilled well. Nos. 160 and 161 were taken from flowing artesian wells of similar depth; the former shows the effects of neighboring manure banks. No. 157 represents the city water taken from the tap in Dr. Blackmar's residence. Nos. 158, 159 represent two analyses of Fountain lake, the former taken from the center, the latter from the wave-lapped manure heaps; and these, even in their incompleteness, show plainly at least one source of pollution. Such conditions as those prevailing at Fountain lake render an analysis entirely superfluous. When polluting material is actually in the water there is small need to produce chemical evidence of organic contamination.

Oakland—The town supply, a well drilled 100 feet, is the only good water we were able to secure in the village. Three samples (Nos. 164, 166, and 167), were taken from dug wells, all of which evidenced pollution.

MOWER COUNTY.

Austin—The city supply consists of the mixed waters of two deep and two shallow artesian wells, situated near the Cedar river banks. The two deep wells are 600 feet each, twenty-four feet in sand and 576 feet in rock. The shallow wells are 135 feet each, twenty-four feet in sand and eleven feet in rock. An outhouse is 150 feet distant from the wells. As the mixed waters gave an unsatisfactory analysis, the reservoirs were emptied, and we examined specimens of the two deep artesian wells, mixed, and the shallow wells separately. The deep wells were good, but the more shallow wells gave a suspicious result. We requested laboratory samples, but none have been sent.

The city water is supplemented at times by water taken from the Cedar river. This stream furnishes also the city ice supply.

Cedar river is contaminated by numerous dumps, by refuse from a tannery, by a small sewer, and by a graveyard on its banks, where the soil and subsoil is sand and quicksand.

The ice and supplementary water supplies are both taken at a point *below* all the above contamination. A sample of the ice was examined (No. 183); also, a sample from the river near the graveyard (No. 184), and another near the intake pipe (No. 178). All three were condemnable. We recommended cutting the ice above the graveyard. The city intends to drill for new wells. No. 172 was taken from the Sargent spring, a heavy flow of water forming a considerable pond and creek running toward the Cedar river. Its environment is practically that of a private park, with grassy shores.

Nos. 173 and 174 were taken from two fine springs, within ninety feet of each other. Saxies' spring (No. 180) is probably somewhat contaminated by a pile of manure on the ground above it. Another sample should be examined before final judgment is passed upon the water. Another fine spring is the Herzog (No. 181). It has a considerable flow, and is located in a clean looking grove. The above springs have been considered as possible sources of Austin water.

A fifth spring sample was taken from the graveyard, but on high ground. Here also another analysis would be advisable, because the spring was considerably used. Nos. 175, 176 and 177 were taken from shallow wells. No. 179 represents Dobbin's creek, a stream formed chiefly from the overflow from the Sargent spring, which should furnish an excellent water, but this stream unfortunately passes through farm yards before reaching Austin.

Grand Meadow—In this village seven samples were taken, in which only two were available for the chlorine. The town well, represented by sample No. 185, is an artesian, coming through thirty-five feet of rock and thirty-five feet of clay and gravel. The ice supply is cut from Deer creek, a small tributary of the Root river. A sample of this water is represented by No. 188, taken one and three-quarter miles east of Grand Meadow. Some of the ice was also examined (No. 189), but this had not been melted in a satisfactory manner.

The analyses were all suspicious; other samples were later sent to the laboratory (Lab. Anal. 510 and 511) and condemned. Waters represented by Nos. 186, 187 and 192 were considered suspicious, and likewise examined in the laboratory (Lab Anal. Nos. 512-514). No. 190 was taken from a spring in Mr. Lockwood's pasture near Deer creek.

FILLMORE COUNTY.

Spring Valley—The village spring is located in a valley, where it is likely to receive town drainage from both hills. Its partial analysis was passably good, but owing to its situation we considered a second examination advisable. The ice supply, taken from a pond three miles above the village, was not above suspicion (No. 303).

In this town people living in the second story of tenement houses have an arrangement whereby all liquid refuse passes by troughs to a back alley. There it runs rampant, and produces a highly unsanitary condition. The son of the Commercial Hotel keeper was a typhoid patient while we were at the house, and the father attributes his illness to the filthy condition of the alley, over which he has no control. Another nasty condition was found where a citizen was using his old artesian well as a cesspool, and probably contaminating many of the town wells.

An analysis of both public school wells gave evidence of probable contamination. A reqnest was made that other samples be sent to the laboratory, but this has not been complied with. The village has a small sewer, emptying into Spring Valley creek—a small, slow-running stream, passing through the heart of the village, and receiving the usual filth on its way. This highly unsanitary method of sewage disposal should not be tolerated.

No. 193 was taken from the shallow well which forms an auxiliary town supply. An outhouse and barn were fifty feet distant on the level.

Nos. 194 to 201 and 204 were taken from wells of various depths and on both hills. Most of these pass through considerable rock, and all show degrees of contamination. No. 202 was taken from a large spring one mile east of town.

The pollution of these subrock waters as evidenced by the chemical examination may be due to one or all of the following possible causes:

1. The geological strata of the county, given in the state survey, are as follows:

Trenton limestone.
St. Peter sandstone.
Shakopee limestone.
Jordan sandstone.
St. Lawrence limestone.
St. Croix sandstone.

The town is built on the sides of an ancient gorge cut by the Spring Valley creek. The edges of the rock strata, as exposed by the water cutting, have been so acted on by frost, air, etc., as to exhibit innumerable crevices, apparently extending far into the heart

of the stratification. In several places where cellars were being dug, and where other cuts had been made, these crevices were in evidence. consequently, the natural drainage would carry the effluent of the numerous cesspools and vaults in all directions from the source of pollution to the neighboring wells.

2. In the limestone areas of this county are numerous depressions, known as "sink holes." These were formed by breaking through of the drift where it was spread over some preglacial rock canyon. In some places these sink holes are numerous, and often extend to great depths. In past times wounded wild animals have been known to creep into them to die, and at the present time they are a great convenience to the far-sighted rural inhabitants, who find in them excellent burial cavities for domestic animals, regardless as to whether death has been due to accident, old age, or disease. These are also very convenient natural cesspools which never fill up. Such conditions alone might account for endless pollution of water.

3. The old artesian well now being used as a cesspool, as previously spoken of. It is surprising that there is any good water in the village.

Wykoff—The village was putting in a new system of wells, which were not available when we passed, but samples were later forwarded to the laboratory (Lab. Anal. Nos. 574, 575).

Fountain—Nos. 205 and 206 were taken from the town supplies. Both are good waters. The geological formation consists of

Yellow limestone	66 feet	Sand rock	90 feet
Blue limestone	26 feet	Gray limestone	44 feet
White limestone	22 feet	White sand rock	40 feet
Blue clay stone	42 feet	Gray limestone	
White limestone	26 feet	Sand rock	

The water comes from the sand rock.

Nos. 207, 208 and 209 were taken from the three town cisterns, dug twelve feet and built of masonry. No. 207 shows some pollution, and we recommended a thorough cleaning of that tank.

Preston—This village is supplied by two excellent springs (No. 210). They are located near the Root river, with clean surroundings. Samples Nos. 212, 214 and 217 were taken from private wells, of varying depth. As in Spring Valley, some of these passed through considerable rock, yet they show evidence of pollution. No. 211 represents a fair sample of melted ice. Some of the Preston samples appear also in the laboratory analysis (Lab Anal. Nos. 532 to 539).

Lanesboro.—The village is supplied by a good spring, but at the time of analysis the reservoirs were not kept clean. We recommended covering the one which was open and cleaning out both. Analysis of this water is shown under No. 215. The city well, used chiefly for fire purposes, is also an excellent water (No. 218). It is located on a high bluff, and passes through 215 feet of rock. The ice supply, represented by No. 225, is cut from a mill pond in the Root river. This pool is also used for a swimming place, which practice, we suggested, should be stopped. Moreover the analysis of the river was poor (No. 322). In the Sylvan Park there was a stagnant pool which received considerable pollution from adjacent residences, and formed a public nuisance. It could easily be drained. An analysis of the town spring water had been made at the laboratory some time previous to this visit, and had shown same to be of good quality. No. 216 was taken from the Sylvan Park spring, a water previously condemned. The source of pollution was evident, to-wit, a closet 100 feet and a barn 200 feet distant, with an ancient cesspool "somewhere near."* Nos. 217, 219 to 224 are from Lanesboro, representing the usual type of water from shallow wells.

Rushford—The village water supply is taken from an artesian well, 285 feet deep, in green slate rock, located 150 feet up the side of an uninhabited, rocky hill. In this apparently organically pure water we found the first indication of a saline district. Its chlorine is 1.04, or about seventy-five per cent greater than in the wells west of it.

Nos. 228 and 231 represent shallow wells. Another analysis should be made from the well represented by No. 229 before an opinion is given as to the quality of the water. No. 230 represents another Root river specimen taken at Rushford, and again showing nitrites. Rushford's ice supply is taken from Rush creek, represented by analysis 232.

At the time of this visit to Rushford we had no expectation of finding a chlorine district beginning at this place, but rather considered the town well's chlorine the resultant of some ancient contamination, hence we passed on to Houston, only to return later.

The analyses will be somewhat mixed and difficult to separate into counties from here on.

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*A Lanesboro citizen who recently visited our laboratory stated that this spring was yet in constant use as the health officer had not warned them of its pollution.

SOME HOUSTON COUNTY TOWNS AND ENVIRONING COUNTRY.

Caledonia—A drilled well, 300 feet deep, supplies the village. Its strata are: Loam and clay, seventy feet; limestone and sandstone, 230 feet. Its analysis is represented by No. 233. It is located in the valley. It yielded a high clorine (1.3), and also strong nitrates. Consequently its chlorine may be, and probably is, partly due to ancient contamination. Its analysis otherwise evidenced present purity (Lab. Anal. No. 493). Nos. 234 and 236 were taken from drilled wells, sixty to eighty-two feet deep, all of which are condemnable, both from analysis and environment. No. 237 was taken from a drilled well three miles north of Caledonia, and located on high ground. No. 238 was from a little creek which empties into Root river. This sample and No. 239 were taken at the small village of Sheldon. Other samples of water in the vicinity of Caledonia will be referred to later.

Houston Village and Environing Country—The first water examined in Houston was from the well supplying the hotel, a dug and driven well, in loam and sand, with barn fifteen feet and outhouse forty feet distant on the level. The quality of the water is shown under analysis No. 240. Looking about for some good drinking water, we tried a flowing well, 284 feet deep, and drilled through 148 feet of sandstone, near a livery barn, represented by analysis No. 241. The chlorine assured us that this also was somehow polluted. Next we examined a flowing artesian well still deeper, and passing through 160 feet of rock, represented by analysis No. 242. Here the environment was apparently excellent, but again the chlorine persistently demonstrated a still worse water. Another flowing well, represented by No. 243, was then tried, one block from the last well. This one was 300 feet deep, passing through some 200 feet of sandstone, and was far removed from any source of pollution. But the chlorine was identical with the well represented by No. 242. We began to despair of finding a good drinking water, when it suddenly dawned upon us that it was the natural salt giving us this reaction. We then made as complete an analysis as lay within our power, and found no further evidence of contamination. Nos. 245 to 269 represent other samples taken from Houston village flowing wells, and will be further discussed under "Chlorine." The general geological data about Houston, as given by the village well driller, is as follows:

Sand	20 feet	Clay rock	25 feet
Blue clay	60 feet	Sandstone to the bottom..	
Sand and gravel	20 feet		

The wells, as may be noticed from their depth (245 to 339 feet), pass through considerable sandstone. They present, moreover, a uniform absence of nitrates and nitrites, and the consumed oxygen of such as were taken was low. That this chlorine is a result of contamination either past or present is highly improbable.

A detailed consideration of wells in the vicinity of Houston village will be found under "Chlorine."

Reno—The village has no public well, but several drilled wells were sampled (Nos. 445, 447 to 449), of which the soil and rock were given as clay and sandstone. No. 446 was taken from a spring supplying the village school. No. 450 was from a spring four miles east of Caledonia, and No. 451 from the north branch of the Kruker creek, one-half mile further south.

At FREEBURG the miller has a magnificient flowing well, 650 feet deep. It passes through eight feet of clay, thirty-eight feet of sand, then sandstone, and finally red ochre (J. R. Graf). The flow began at a depth of eighty feet. (See Lab. Anal. No. 478.) Sample No. 454 was taken from a good spring two miles northeast, and No. 445 from a drilled well, in clay and rock, four miles northeast of Freeburg.

At BROWNSVILLE the important well is the "Madcap," so called from the destruction it caused to property when first tapped. Its flow was later checked by a large amount of rock, timber etc., placed upon the exit, but it still yields a large volume of water. Its analysis is represented by No. 457. A spring one and a half miles west of Brownsville is represented by No. 456, while No. 458 was from a drilled well three and a half miles southwest of Brownsville. Samples were taken from three other drilled wells between Caledonia and Brownsville (Nos. 459 to 461). A drive was made from Caledonia to Spring Grove, thence to Black Hammer, by way of Riceford, thence back to Caledonia. Nos. 452 to 468 were from deep country wells, in loam, clay, sandstone and flint rock.

The village water at SPRING GROVE is from a mixed deep and shallow supply. It yielded a suspicious analysis, as shown under No. 459. Subsequent samples of these two wells were examined in the laboratory (Nos. 525, 526).

Nos. 471 to 475 were all from deep highland wells, on the road between Spring Grove and Riceford. The deepest sample taken between Riceford and Caledonia was that from Senator Johnson's well, 300 feet deep, of which 275 feet is through rock, with no reasonable evidence of contamination. Nos. 477 to 480 were from deep drilled wells, between Black Hammer and Caledonia.

Winona—The city supply, represented by No. 387, consists of mixed water from two flowing artesian wells (No. 380) and one dug well (No. 381). The artesian wells showed a high chlorine, but no evidence of organic contamination (Lab. Anal. No. 476).

The water from the shallow well was evidently polluted. The well itself was very dirty. It is located close to the river bank. Some half dozen outhouses were within a stone's throw, and the well is in a direct line with the drainage toward the river from these, so that it probably received pollution from this source. Chemical analysis evidenced contamination. No. 392 was taken from the Mississippi river, near the shallow city well, which is popularly supposed to be river water. The analysis, however, scarcely supports the theory.

A number of city taps in Winona yielded in most instances an analysis showing dirty pipes (Nos. 386, 388 and 389). We recommended thorough cleaning of the present shallow well, then a further analysis in order to learn whether the pollution were local to the well itself or due to infiltration. We likewise recommended flushing of the city taps at necessary points.

Exclusive of the city water, twenty-one samples were taken in and about Winona, including the villages of Minnesota City and Rollingstone. No. 382 was taken from Lake Winona, a long, narrow body of water, with a mud bottom. Several springs feed it from the south shore, and from these samples Nos. 383 and 384 were taken. No. 385 was from a drilled well near the above springs. The city cemetery is located on a hillside which drains into the lake.

On the road from Winona to Minnesota City two wells of especial interest were sampled,—the Laird-Norton and the Miller sheep farm flowing wells. Both gave a high salt reaction, and will be referred to under "Chlorine." Nos. 395 and 400 were taken from common dug or driven wells, in sand or gravel.

Rollingstone—The public well is drilled 238 feet,—through clay, five feet; sandstone, seventy-five feet; mixed sand and clay, sixty-eight feet, and solid rock, ninety feet. No. 403 was taken from a tap in Rollingstone. Nos. 404 and 405 were from drilled wells, through clay and sandstone, with possible pollution near. Other samples in Winona county will be considered under "Chlorine." Short stops were made, while passing, at important towns between Winona and Dodge Center.

SOME TOWNS IN WINONA, OLMSTED AND DODGE COUNTIES.

Lewiston—The public water supply is from a drilled well, through loam six feet, clay, twenty feet; quicksand, ten feet; limestone, 215 feet; and sandstone, —— feet. The well is on high

ground, with the village street passing it on a level. Such depth and quantity of rock should protect from all surface pollution, but the analysis was decidedly unsatisfactory, and a further study should be made of this well. No. 412 was taken from a well similar to the village supply, but somewhat deeper. Its analysis was entirely different, and bears out the theory of pollution of the public well from some source. Samples of these waters for laboratory examination were asked for, but have not yet been sent.

St. Charles—The water supply is from a well 942 feet deep, through

Sandstone ....20 feet	Sandstone and soapstone ....280 feet
Limestone ....200 feet	Soapstone and clay ....200 feet

Its analysis was somewhat peculiar, and a second sample was asked for, but has not yet been sent. Nos. 414 to 416 were from springs between St. Charles and Clyde postoffice, by way of Saratoga. No. 417 was from a drilled well, in loam, three feet; clay, forty-seven feet; and rock, 200 feet. It is eleven miles southeast of St. Charles, and some twenty-seven miles northwest of Houston. No. 418 was from a similar well near by. Nos. 419 and 420 were taken on the return.

Dover—The samples were all taken from wells about ninety feet deep, in sand, clay and sandstone (Nos. 422 to 426). These should be examined further.

Eyota—The town well passes through clay, ten feet; limestone, 100 feet; and blue clay, 140 feet (No. 427); yet it is polluted according to the chemical evidence. Nos. 428 to 431 were also from wells of fair depth, but they yielded an unsatisfactory analysis. Laboratory samples were asked for, but have not been sent.

Byron—The worst sample examined in this village (No. 435) was from the hotel well, dug fifty-four feet in loam, clay and hardpan. Nos. 432 and 433 were from drilled wells, through yellow clay, twenty-five feet; blue clay, fifty feet; and soapstone and sandstone 107 feet. They were apparently good waters. No. 434 was taken from a farm one mile west of Byron. At some time prior to 1897 this well was examined by the state board of health, and pronounced good, in face of the fact that five cases of typhoid fever had occurred among those living on the farm. Investigation at this time, however, brought to light the facts that said five cases of fever were exclusively among the hired men, who preferred to drink, not from the well examined, but from a pasture well and a cistern. Sam-

ples of these waters were not then sent for analysis, but at this time they were inspected by Mr. Carr, who pronounced them so dirty that chemical examination would be useless.

Kasson—Three samples were taken at this village (Nos. 436 to 438), including the town well, the village supply and the railroad well. None of these were satisfactory. The village was making arrangements for a new water supply.

Rochester —The city water supply is obtained from nine driven wells, thirty-five feet deep, and one dug well, twenty-five feet deep, in sand and gravel. A manure dump is within thirty paces and the vaults of five outhouses are within some 200 feet of this common source. The wells are located close together, on the bank of Bear creek, towards which the general drainage, of course, flows. The location and environment is therefore very poor, and the analysis, represented by No. 439, is such as might be expected with such conditions prevailing. A sample of water was taken from the Zumbro river, where the Rochester ice is cut. Some manure heaps are in evidence close to the bank. The analysis was not good (No. 440). No. 444 was taken from Bear creek, which rises some seven miles southwest of Rochester. It receives sewage from one house and one manure dump, and this contamination is in evidence in the analysis shown.

Laboratory samples of the city water and ice supplies have been repeatedly asked for, but have not yet been forwarded. The dearth of deep country or town wells in the vicinity of Rochester, added to the rigid hotel rates of that place, caused us to hasten our departure with more than usual rapidity.

We afterwards learned that the state hospital for insane was not supplied with city water, as stated to us, but from one deep and certain shallow wells. Most of the water is from said shallow wells, and we fear for their purity, by reason of the sewage disposal areas, no great distance away. Bottles were sent for collection of these samples Sept. 4, 1900, but as yet (Nov. 6, 1900) have not been returned.

WABASHA COUNTY.

Wabasha —The village lies in the valley of the Mississippi. It has no water works, but is supplied entirely by shallow wells, dug or driven in the sand. Their depth varies between twenty and sixty feet, dependent upon the elevation. The outhouses, cesspools and wells are all handy to the houses, and the normal result is a series of impure waters. Seven samples of surface water were taken in Wabasha, and these were amply sufficient to show the expected con-

tamination. Nos. 508 and 509 were from wells supplying the Hurd House, and they plainly show the effect of environment. Both wells are twenty-eight feet deep, driven in sand. The one supplying the table drinking water is represented by No. 509. This is twenty feet from the hotel closet, a dry earth box affair, which is cleaned every day. The filth, however, is merely carried to the manure heap, 100 feet away, and left until a quantity of the mixed excrement has accumulated. It is then hauled to the dumping ground. No. 508 was taken from the laundry well, which is about fifty feet further away from the sources of pollution, and is further protected by the cemented floor of the basement in which the pump stands. The difference in analytical data was sufficient to convince the proprietor as to which was the better water. He promised to discontinue the use of the well represented by No. 509. Nos. 512 and 514 were taken from wells in the public buildings, to-wit, the jail and courthouse. The school we did not sample, as it was in a locked basement. I have, however, small hopes of its purity. Nos. 510 to 511 were common surface waters. Nos. 505 and 507 were from deep wells, on the height of land several hundred feet above Wabasha, that pass through clay, sandstone and limestone. No. 505, however, was taken from a cistern, which diminishes the value of the sample. Nos. 504 and 506 were taken from wells in sand, gravel and clay, with probable sources of pollution. This leaves but two analyses of probably typical wells in and about Wabasha,—No. 507 for the deep country water and No. 508 for the shallow or surface supply.

Lake City.—The city has a public water supply, which had been previously examined and called suspicious (Lab. Anal. No. 551). We found it to be a dug and driven well, some fifty feet in hardpan clay, but located about 175 feet from the Mississippi river and in direct line to receive the contamination from nearby city outhouses. Personal inspection thus reinforced the laboratory analysis, which was still further confirmed by comparison with country wells of similar nature. Other dug and driven wells in the city gave similar analyses, due to similar causes. Nos. 515 to 517 and 520 were from such city wells, and have evident sources of impurity. No. 518 was from a dug and driven well, one-half mile south of Lake City. It is forty feet deep, with no apparent contamination. No. 519 was taken from a spring at the Lake City camping grounds. It shows an excellent quality of water, supporting great quantities of water cress. A drive was made along the Gilbert Valley road, towards Bellvidere Mills. The roads were so bad that we were compelled to cross the ridges four miles from the mills, and return by the Rochester road. Samples Nos. 522 to 535 were taken on this trip, and illustrate a fine series of springs, as well as a number of fairly good driven and drilled

wells. The underlying rock was usually given as sandstone and limestone.

The most interesting water in Lake City is that from the railroad well. The water was first obtained from a flowing supply, at a depth of 820 feet, with the following stratification:

River deposit	207 feet	Sandstone	520 feet
Sand and shale	93 feet		
		Total	820 feet

(105 feet below the sea level).

The water, however, was too salty for use, and the pipe was plugged up, to be opened only on occasions of necessity.

We came very near missing this deeper water, as the present supply is obtained from a dug well fifty feet deep, superimposed above the artesian, and we took a sample of the shallow well, with the depth given to us as 775 feet. A second trip, however, secured the deep water, which was allowed to flow three hours before the sample was taken (No. 537 and Lab. Anal. 480). Nos. 538-541 were from the Mississippi river, taken at the request of the health officer and local ice dealers. No. 542 was taken from across the river, at Stockton, Wis.

Lake City has a small sewerage system, recently constructed, and further polluting the Mississippi river. There is also a bacteria breeder, in the shape of a dirty slough, in the city. During the high water this slough is usually flooded by the Mississippi, which then retires, and the stagnant pond left behind is from then on a receptacle for dumpage of various description. This slough should be filled up.

Plainview—Centering at this town, we made a study of the surrounding country, which included parts of Wabasha, Winona and Olmstead counties. The village well, represented by analysis No. 543, is drilled 692 feet deep.

Loam	2 feet	Sandstone	120 feet
Limestone	40 feet	Limestone	50 feet
Sandstone	30 feet	Green clay	180 feet
Limestone	180 feet	Sandstone	22 feet

The water is excellent, as attested by depth and chemical examination (Lab. Anal. 486). No. 568 represents a sample of water from the Plainview tank.

Driving from Plainview toward Beaver, samples of deep wells and springs were taken, including the excellent ice supply of Plainview, obtained by restraining the waters of a spring some seven miles east of town, represented by analysis No. 549. Sample No. 545 was taken from a common dug well, with an outhouse, etc.,

thirty feet distant. Samples No. 546 and 547 were from drilled wells, in clay, limestone and sandstone. The only Beaver sample was from a well twelve feet deep (No. 550).

Elba —The town pump is in a driven well, twenty-nine feet deep, in sand, represented by sample No. 551 (Lab. Anal. No. 485). This should be occasionally examined, as the trace of nitrous and nitric acids is "suspicious." The White Water river, a branch of the Zumbro, was sampled at Elba (No. 552).

Elgin —The municipal supply comes from limestone, at a depth of 152 feet (No. 553, Lab. Anal. No. 484). A closet and barn were fifty feet distant and we advised their removal. Nos. 555 and 556 were taken from driven wells in the village. Both are poorly located. No. 557 was taken two and one-half miles west of Plainview, on a northwest drive. It is a good specimen of deep water.

Potsdam—The village well is in clay (thirty feet) and rock (170 feet), and its analysis is fairly good (No. 558). No. 559 was taken from a drilled well two and one-half miles west of Potsdam, in 170 feet of rock.

Hammond —The Zumbro river and one shallow well (represented by No. 560) were examined.

Millville —Two driven wells (represented by Nos. 562 and 563) were examined. Out of Millville, and some nine miles northwest of Plainview, a fair sample of deep water was taken (No. 564) from a well passing through clay, twenty feet; rock, 270 feet; sand, ten feet. Its location is on high ground, free from suggestion of impurity. Circling to the east and south, another deep well was sampled (No. 565). It passes through clay, sixty-three feet; rock, ten feet; "muck," three feet; and rock, 221 feet. It yields a good analysis, although the barn is within ten feet. Nos. 566 and 567 were taken from deep wells near Plainview.

Chatfield—Sample bottles have been sent for the town water and ice supply.

DODGE COUNTY.

Short stops had been made the previous summer in some of the towns in this county, and a drive was now made to cover a part of the country. Samples Nos. 598 to 605 were taken, chiefly from springs and deep wells between Dodge Center and Mantorville. No. 606 was from a common dug well. Samples Nos. 599, 602 and 603 represent good examples of Dodge county spring and flowing well waters.

STEELE COUNTY.

Owatonna—The city water supply is a mixture from three wells, having a depth of twenty, eighty and 474 feet. The well or cistern twenty feet deep is in loam, clay and gravel, and furnishes the greater quantity of water. A further supply is obtained from a long gallery, running some 200 feet to the south, and curbed with rotten planking. A separate sample from this gallery well we could not obtain; in fact, we were not informed of its existence for some days. Considerable dissatisfaction existed in the town as to the water supply, and certain trustworthy persons stated that several live but unidentified worms have been found in the tap water. These were probably one resultant of rotten curbing.

Analyses were made of the combined surface, trench and well waters (No. 569); also, of the well eighty feet deep (No. 570); also, of the mixed waters from the wells twenty and 474 feet deep (No. 571); and, finally, of the mixed water from the wells twenty, eighty and 474 feet deep (No. 572). We could not obtain a sample of the well 474 feet deep unmixed, but inferred from its mixed analyses and the analysis of the well eighty feet deep that the deeper supplies were good, but that the surface waters were not passable (Lab. Anal. Nos. 588, 635, 681 and 682). The Straight river is a fair-sized stream, about three feet deep and 100 feet broad, fed by certian flowing wells about ten miles south of Owatonna, and is represented by No. 573. Nos. 574 and 575 represent the deep wells supplying the state school for indigent children. They are within twenty feet of each other, and are drilled through clay, seventy-five feet; gravel, two feet; limestone, soapstone and soft shale. The water from the Owatonna mineral springs (No. 576) is considerably used, and to some extent peddled, in the city. Nos. 577, and 579-581 were taken from shallow wells, in sand and gravel; No. 578 from a well driven in sand and blue clay, and No. 582 from a flowing well, thirty feet deep, with a cow yard adjoining and a barn thirty feet distant. South of Owatonna some ten miles is a series of seven fine flowing wells, represented by Nos. 584 to 590. They are near River Point, and they range from ninety-three to 110 feet in depth. They pass through considerable sand and clay, but through little rock, generally about six feet. The dirty environments were suggestive of pollution, but these waters responded quite well to our tests, as indeed but few flowing wells fail to do. No. 591 was taken from a newly drilled well, located in a grove of trees.

Blooming Prairie—This village is supplied by a well, 165 feet deep in clay, fifteen feet gravel, and fifteen feet clay and shale rock. Its environment, depth and analysis were passably good, although the creamery well, represented by No. 594, which is nearly as deep,

yielded less chlorine. Nos. 594, 596 and 597 were taken from shallow wells, one of which (No. 597) supplies part of the traveling public, and all of which are evidently bad.

WASECA COUNTY.

Waseca—The depth of the Waseca well is given as 1,187 feet by the water-works engineer, and as 1,024 by the state geological survey. The difference is not material. The stratification consists of

Drift	185 feet	Limestone	6 feet
Limestone	6 feet	Green shale	3 feet
Slate and shale	87 feet	Limestone	65 feet
Limestone	16 feet	Shale	3 feet
Sandstone and shale	121 feet	Shale	138 feet
Limestone	255 feet	Sandstone and shale	44 feet
Sandstone	95 feet		
Sandstone	195 feet	Total	1,024 feet

The tap sample (No. 608) yielded nitrites and increased nitrates, which go to show a neglected tank.

The Waseca ice supply is cut from Clear Lake, a small body of water one mile east of town. The village sewer empties into a slough at one end of the lake, and its filth is attested by the high chlorine of the lake specimen (No. 616).

Fifteen miles south and southwest of Waseca, in the vicinity of MINNESOTA LAKE, we found a group of five flowing wells, with but slightly varying chlorine (Nos. 609-613). The depth of these wells was difficult to ascertain; only one was given—ninety-one feet (No. 612).

New Richland—The town water supply is from a well 114 feet deep (No. 614), in loam, four feet; yellow clay, two feet; blue clay, eighteen feet; rock, ninety feet; and yielded a fair analysis. There were, however, two closets within forty feet, and we advised their removal. No. 615, taken from a flowing well four miles north of New Richland, shows the lowest chlorine reaction thus far found in Minnesota,—.095 parts per 100,000.

Samples were taken along the roads to WATERVILLE, JANESVILLE, MADISON LAKE and EAGLE LAKE, in Le Sueur, Waseca and Blue Earth counties.

Waterville—The village supply is represented by No. 617. No. 618 was taken from a flowing well, but its outlet is now four feet below the surface. Near this well is the creamery flowing well, eighty-five feet deep. The sample was taken from the tank.

Elysian—The village well is 287 feet deep, in clay, quicksand, gravel and sandstone. The sample was difficult to collect as water could be obtained only from a spray from the machinery, which probably accounts for the trace of nitrates and nitrites. The tap sample is represented by No. 621. No. 622 was taken from a lake near Elysian, with clear water and good surroundings. South-west of Elysian, towards Janesville, water from one deep well represented by No. 624, and one shallow well represented by No. 625 was taken. Lake Elysian is about seven miles long by one-half mile wide. It was formerly a great resort for fishermen, but is now covered with a green scum, and for some reason the fish die in great numbers. Wagonloads of dead fish are hauled away from the beach. The consumed oxygen of this water was remarkably high, even for a lake.

Janesville—The public water supply is from a driven well eighty-five feet deep, in gravel, located in an alley, with a closet within sixty feet, on the same level. It is consequently polluted (No. 656). Compare with the water represented by No. 627, which is from a well in the same vicinity, with the same depth, the same soil and subsoil. No. 628 was taken from a tubular well, in sand and gravel.

Eagle Lake—The village well is represented by No. 630, and should be further examined.

Madison Lake—The village well is 112 feet deep, in clay and gravel, and responded well to our tests; but there is a barn within twenty feet which is a menace and should be removed. The lake itself is about three miles long by one mile wide, with wooded shore. Its water is represented by No. 632.

Greenland Postoffice—The place lies three miles west of Elysian. Its water supply is represented by No. 633.

BLUE EARTH COUNTY.

Mankato—The waters from this city and environment were examined later in the season, but are best treated at this point. They are represented by Nos. 776 to 784. The most interesting well of this group is in the vicinity of MINNEOPA, some five miles southwest of Mankato. It was drilled some twelve years ago, in a search for oil. Instead of oil a fine flowing water was the result, and this has continued without intermission to the present day. Drillings were made to a depth of 1,000 feet, but the principal flow comes from a fine water-bearing sandstone, at 575 feet. The stratification of the well is as follows:

Quicksand and gravel.	50 feet	Clay and shale	160 feet
Blue clay	10 feet	Course red sandstone.	25 feet
Sand	28 feet	Water-bearing s'ndstone	270 feet
White sandstone	28 feet	Quartzitic conglomerate	
Flinty chips	24 feet		

The chlorine of this well is high, and further study of its water will be made. Its analysis is given under No. 776. No. 777 was taken from the Blue Earth river, seven miles south of Mankato. Nos. 778 to 780 were taken from three springs, with good flows of water. They come out from the sand in a little island in Blue Earth river. Nos. 781 to 783 were taken from deep flowing artesian wells near the city wells. The Mankato supply is a mixture of two artesian wells, 660 to 700 feet deep, in blue clay, sandstone and limestone. (For other examinations of this water, see Lab. Anal. Nos. 591, 609 and 645.) The deep well at Mankato, depth 2,204 feet, could not be sampled.

The MANKATO MINERAL SPRINGS are eight miles west of Janesville, and nine and one-half miles southeast of Mankato. Environment and tests were satisfactory (No. 629).

Mapleton—The village supply is from a drilled well, 265 feet deep, in loam, clay and sand rock, and is represented by No. 635. No. 638 was taken from an artificial lake, two acres in area, from which part of the ice supply for Mapleton is cut. It should be further examined. No. 641 was taken from the Maple river, ten miles south of Mapleton, from which another part of the ice supply for Mapleton is taken. A fine series of flowing wells were examined between Mapleton and AMBOY, by way of STERLING CENTER. These are represented by samples Nos. 637 to 658, except the two above mentioned, viz., 638 and 641. This series is comparatively constant in its chlorine, the amount being least in Sterling Center. None of these wells are deep, yet they all yield a fairly good, typical analysis.

In AMBOY the depth of the village well was given as 485 feet, but the analysis, as shown by No. 659, was not good, and should be repeated. The examination of a tap specimen (No. 660) evidenced further pollution in the tank.

Lake Crystal—The village has no municipal supply, and the water is chiefly from dug wells. No. 661, taken at the Commercial House, and Nos. 662 and 664, taken from public drinking places, represent contaminated surface waters. The lake itself, represented by No. 663, is a passably good water, and it is from this that the ice supply is taken.

There is one deep well at the mill, but the sample was difficult to collect, and had to be transferred from a pail to our bottle. Said pail was probably not clean, and this may account for the nitrites shown in the analysis. The chlorine, however, was not high. This well is of especial interest, because it penetrates the granite. It passes through

Drift	145 feet	Shale	175 feet
Sandstone	40 feet	Sandstone	100 feet
Limestone	140 feet	Granite	35 feet

WATONWAN COUNTY.

St. James—The high alkalinity renders the city well undesirable for domestic purposes, although its organic analysis is good. The water comes from a depth of 101 feet, through St. Peter sandstone, gravel, sand and loam. The ice supply is taken from Long lake and St. James lake,—a shallow, weedy, muddy supply, represented by No. 670—and also at times from the Watonwan river, at Garden City, Blue Earth county. A small sewerage system empties into St. James creek. This is a particularly dirty stream, both above and below the sewer's outlet, as shown by Nos. 667 and 668 respectively. It empties into the Watonwan river, a tributary of the Minnesota. The springs in "Hundred Acre Slough," represented by No. 666, are somewhat overgrown with vegetation, and this explains the high amount of oxygen consumed. Nos. 669, 671 and 673 were taken from shallow wells of suspicious or unmistakably bad quality. No. 671 was taken from the well which supplies the Park Hotel, and No. 673 from the well that supplies the Gibbs Hotel, the two important hostelries of the town. The high school well, represented by No. 672, has an outhouse perilously near, which should be removed.

Madelia—The samples were taken out of the regular course, hence the numbers are high. The village supply (No. 790) was taken from a tubular well 212 feet deep drilled through

Clay and hard pan to	65 feet	Hard pan to	198 feet
Clay to	130 feet	Fine sand to	200 feet
Water sand to	235 feet	Course sand to	202 feet
Gumbo to	170 feet	Gravel to	206 feet
Water sand to	174 feet	Sandstone to	212 feet
Fine sand to	196 feet		

(See, also, Lab. Anal. No. 668.)

A popular spring on the Watonwan river gave a fair analysis (No. 792). The ice supply of Madelia is Lake Feldje, a shallow, weedy

lake about one mile square, which will be examined further. Sample No. 795 was taken from the melted ice from this lake. No. 793 was taken from the Watonwan river, a shallow stream in the sand. At the time of taking it was a fairly good water, but by the present time it has been polluted by the new Madelia sewer, which empties into it. Below the sewer the river winds through a large field, where some seventy cows, belonging to individual families in town, are pastured.

Lower down, the farmers of the neighborhood have built a dam, and from the Watonwan river thus restrained, a good supply of ice was cut, but this will now be a polluted source.

Further on, this river passes Garden City, where ice is cut for several towns, including St. James. This ice will probably be polluted in the future, if it has not been in the past. (Note St. James creek.)

A statement of the local health officer in this town is typical of the conditions governing rural sanitation in Minnesota. He says: "It is discouraging to investigate waters and send samples for analysis, because the people continually refuse to close condemned wells."

COTTONWOOD COUNTY.

The interior of the county was not easily reached, for want of railroad facilities. We decided to work the lower part from Windom and the north from towns in Redwood county.

Windom —The public water supply was formerly obtained from a well, dug eighteen feet, with nine pipes then driven into the clay some eighty feet. All of said pipes but one, have gradually clogged up, so that the water is now practically a surface quality, represented by No. 675. The usual outhouse is within some thirty feet of the well. Neither analysis nor environment was satisfactory, and the laboratory analysis condemned the supply (Lab. Anal. No. 663).

The Windom ice supply is cut from a mill pond in the west fork of the Des Moines river. The health officer complained of constant pollution of the stream above the dam by small sewers, manure heaps and garbage of all kinds, and his statements were verified by inspection. These conditions should certainly be remedied, as they are dangerous to the community; but there seems to be no available authority. We reported the matter to the secretary of the state board of health. A good ice supply could easily be obtained from Fish lake, represented by No. 679, some four miles southeast of Windom.

A drive was made northeast from Windom, stopping at Bingham and Mountain Lake, and then turning north. No. 680 presents

a curious analysis for a drilled well 320 feet deep, with no visible or known contamination.

Mountain Lake—The village well is dug in loam, clay and quicksand, with nearby outhouses. Its water is represented by No. 681. The village has no sewerage system, and its ice supply is cut from a branch of the Watonwan, which was dry at the time of our visit. Nos. 682 and 683 were of the common dug well variety. Our drive was continued sixteen miles north of Mountain Lake, in order to sample a deep flowing well, but this proved to be but twenty-five feet deep when we examined it (No. 684).

JACKSON COUNTY.

Heron Lake—The village well is drilled 220 feet, in loam, three feet; blue clay, 100 feet; yellow clay, eighty-three feet; and rock, thirty-four feet. It is used chiefly for fire purposes. The town has no sewer, save for dishwater. Nos. 687 and 688 were taken from driven wells in sand, clay and gravel. No. 669 was from a well 304 feet in loam, clay and sand, and the sample was taken from the tank.

Heron lake itself is marshy and weed grown. A sample of the ice taken from this lake is represented by No. 690. No. 691 was taken from some spring (?), collected by the local health officer, and handed to us without any data.

MURRAY COUNTY.

The southern part of this county was worked from Slayton, the northern part from Tracy.

Slayton—The old village water supply, represented by No. 692, is from a well, 208 feet deep, in clay, quicksand and gravel, with an outhouse and barn within thirty feet. A new well is under way.

Much of the ice supply is taken from Lake Shetek, some ten miles north, and sampled from Tracy (No. 734). Part of the ice is taken from a small spring-fed creek, represented by No. 707. No. 694 was taken from a well 206 feet deep, in clay and gravel, on the Murray county poor farm. It is adjacent to the chicken yard, and the outhouse is about 100 feet distant. Nos. 695-696 were taken from flowing wells three miles south of Slayton. These were through considerable blue and yellow clay and some rock. Nos. 697 to 699 were taken from driven wells five and one-half and four miles south of Slayton. A 500-feet-deep well was sampled one and a half miles west (No. 700) and a good spring two and a half miles west of Slayton (No. 701). Nos. 702 and 703 were from the vicinity of HADLEY,

the former from a driven well, the latter from a spring. Eight miles northwest of Slayton another good spring sample was secured (No. 704). Three miles southeast of Slayton a sample from a flowing well, 157 feet deep, was taken, but the analysis was unsatisfactory (No. 705). A better sample was secured seven miles southeast from Slayton (No. 706), from a heavy flowing well, in clay, 100 feet deep.

PIPESTONE COUNTY.

Pipestone—The village is supplied by two drilled wells, 240 and 196 feet deep respectively, in loam, two feet; yellow clay, twenty-five feet; and quartzite to the bottom. The water is represented by samples Nos. 708 and 709. This supply evidences a sometime pollution, as shown by the high chlorine and nitrates. Laboratory analysis gave low ammonias, and the water was passed, but I consider it advisable to make occasional analyses, especially of the well 196 feet deep. The possible source of pollution is the Calumet Hotel cesspool, directly across the street from the wells. The village was putting in a new dug well, in the drift, some 400 feet from cow barns. Its position was such as to insure pollution in the future, unless said barns were removed. We advised another location, which was afforded by a field belonging to the town, and far away from all objectionable material. Sample No. 715 was taken from the new surface well, but could hardly be considered fair, as the water contained considerable floating material, the well being as yet unfinished. It would seem that some sanitary authority ought to be consulted as to the location of wells supplying the people's drinking water. It is much easier to prevent an evil than to remedy it.

No. 714 was taken from a spring in the Indian reservation, near the Pipestone quarries. No. 716 was taken from a popular street well, near the Calumet Hotel. Pipestone ice (No. 717) is cut from two tiny lakes in the Sioux reservation, near the Indian industrial school, and the sewage from that school starts in their direction, but some hundreds of feet away. The lakes nestle in the quartzite rock, and are probably good water; but another analysis will be made in the laboratory. Nos. 718 to 722 were from drilled wells taken at Pipestone and in the country about, to determine the chlorine unit. No. 723 represents a good specimen of surface water, No. 724 a poor one.

LINCOLN COUNTY.

By reason of the poor railroad facilities at the time of our visit, but little work was done in this county. There were no known deep wells, and but few springs, near the village of Lake Benton, and the new road to Lake Hendricks was as yet in preparation. A few samples were secured in and about Lake Benton, and some were taken

in northern Lincoln county, by working south from Canby (Yellow Medicine county).

Lake Benton—The village well is dug some fourteen feet in quicksand and gravel and has brick curbing. A barn, eighty-one feet, closet, 100 feet, and cattle yards, 250 feet distant, constitute a constant menace to the purity of the water. That some infiltration has already begun is shown by the chlorine of the analysis (No. 726). Barring chlorine and nitrates, the analysis is good (Lab. Anal. No. 667). The removal of the sources of pollution was advised. Nos. 725 to 727 were taken from two springs near the lake. No. 728 represents the melted Lake Benton ice. The lake itself receives sewage from the creamery. (Notice the high chlorine.) The Tremont Hotel water, represented by sample No. 729, is from a driven well seventy feet deep, in sand and gravel, with a closet fifty feet distant.

LYON COUNTY.

Tracy—The most important aspect of our work in Tracy was the investigation of one of the public water tanks. Said tank was built in the ground some ten years ago, and had never been cleaned up the date of our visit. Moreover, it was built with a double top, and a small window-like space opened from this miniature garret into the open air. This, of course, furnished an excellent house for small birds and rodents, whose excreta covered the floor. The best description of the condition, however, is furnished by the chemical analysis of the water direct from the well and direct from this tank (Lab. Anal. Nos. 684 and 685 respectively). No. 730 of this series represents an analysis from the tank alone. An able health officer assisted us in this work, and we understand succeeded in persuading the council to clean out the filth.

The stratification of the well was given as follows by the engineer, Mr. W. E. Swanson:

Soil	1 foot
Yellow clay	19 feet
Blue clay	100 feet
Sand and gravel	5 feet
Blue clay	20 feet
Sand and gravel	20 feet (much water)
Gray shale	12 feet
Sand shale	20 feet
Gray shale	213 feet
Sand shale	60 feet
Brown shale	23 feet
Sand and limestone	32 feet (water)
Sand rock	5 feet
Sand and shale	30 feet
Quartz	7 feet
Brown shale	24 feet
Quartz	8 feet
Sandstone	8 feet (no water)
Quartz	10 feet
White marl	10 feet
White and red marl	15 feet
Light colored quartz	27 feet
Red quartz	5 feet
Granite	33 feet
Total	724 feet

Southwest of Tracy, on the road to Lake Shetek, a sample of Lake Siegal water was taken (No. 732), and of a good spring (No. 733). Lake Shetek itself is some nine miles long, and from one to two miles wide. It furnishes ice for Tracy, Slayton and Currie. It is something of a summer resort, but not subject to much pollution, as evidenced by its analysis (No. 734 and Lab. Anal. No. 489). Sample No. 735 was evidently, from its taste, a heavily charged mineral water. Unfortunately, an outhouse had recently been constructed sixty feet from the well; hence we were unable to classify the chlorine as natural or from pollution. No. 736 was taken from a well forty feet deep, bored in the high sand bank of Lake Shetek. Nos. 737 to 739 were from flowing wells northwest of Tracy.

Marshall—In the vicinity of Marshall comparatively soft flowing waters are obtained at a depth of 248 feet, and a much harder, pipe-destroying water at 396 feet. The latter forms the present city water supply (No. 741), and is organically good, but dangerous by reason of possible destructive action on the water pipes. A new well, 248 feet deep, has been drilled, but is not yet in use (No. 742). They are now putting in a dug well. The stratification of the well that is 248 feet deep, in Marshall, was given by a local driller as follows:

Yellow clay	20 to 30 feet	"Ancient tree formation"	(?) feet
Sand streaked clay	20 to 30 feet	Rock (yielding water)	(?) feet
Sand	20 feet		
Soapstone	14 feet		
Rock	2 to 10 feet	Total	248 feet

The well, which is 398 feet deep, was drilled by Mr. S. Swanson of Minneapolis, who gave the following strata:

Loam	3 feet	Sandstone	11 feet
Yellow clay	15 feet	Shale	2 feet
Yellow cay and sand	60 feet		
Blue clay	300 feet	Total	391 feet

No mention is made of the "ancient tree formation" nor of the rock above or below it, as given by the Marshall drillers.

The Marshall ice supply is cut from a spring and fall pond, formed by damming the Redwood river. At the time of our visit there was practically no water in the pond, so no specimen could be obtained. This, however, was no loss, as any chemical examination of such self-evidently polluted water is merely a waste of time.

Two slaughter-houses are located a short distance above the dam, and one of them (the one nearest town and the ice supply) is a marked example of unlimited filth. The premises were inspected by Mr. Carr, who could scarcely endure the vile stench arising from

the masses of fecal matter, decaying heads, etc., of slaughtered animals. These masses of abomination, several feet thick, are distributed over the yard, and piled in great heaps outside the fence. Said yards and heaps are on a slope of ground reaching the very edge of the Redwood river, about half a mile above the dam, and into this "ice supply" the miserable mixture is constantly draining. Below the dam there was no water, but a short distance further on a few springs arise and start a tiny stream. On reaching the town this is immediately augmented by private sewers and every conceivable variety of outhouse and domestic drainage. Carrying this constantly increasing pollution, the stream slowly winds through several blocks, in the heart of the village, a constant and dangerous menace to public safety.

By request of representative citizens, a sample of Lake Marshall water was taken during a necessary stop-over between Canby and Granite Falls. This lake lies in the drift, some five and one-half miles southeast of Marshall. A single farm is cultivated on its shores, and all buildings are placed back some distance. It is somewhat weed grown at one end, but would form an acceptable source of ice (No. 747).

Ten samples from drilled and flowing wells were taken in and near Marshall (Nos. 741, 742, 744, 746 to 749, 750 to 752). All yield a high chlorine, but it is noticeable that the percentage of the lower flow is considerably less than that of the upper, which is directly opposite to the conditions obtaining in Houston county. The flows here are also separated by a rough 100 feet.

A point of considerable interest in sanitary water inspection is the small trace of nitrous acid present in several of the deep flowing wells. It is possibly due to the interglacial peat formation, which presumably is identical with the "layer of ancient tree" formation referred to in the stratification of the Marshall well of 250 feet, and from below which the water comes. Nos. 745 and 753 represent samples taken from dug and driven wells in sand and clay.

West and southwest of Marshall samples were taken to determine the direction of the chlorine. Nos. 754 to 758 were taken from springs and flowing wells. Another series of five flowing wells, about 250 feet deep, was secured at Marshall, and they also exhibit the same high chlorine and the small amount of nitrites (Nos. 759 to 762, and 774).

No. 763 was from a dug well. Nos. 766 and 767 were from drilled wells some distance north of Marshall, quite near together. No. 768 was from the vicinity of Stavenger, in Yellow Medicine county.

Going southeast from Stavenger high chlorine samples were obtained, in the direction and vicinity of Cottonwood, No. 769, however, gave low chlorine, but was from a comparatively shallow

well, showing that the salt was not on the surface. No. 770 was taken from a drilled well, two and one-half miles east of Stavenger. Its marked nitrates, in addition to a poor environment, suggests a salt due in part, at least, to contamination. The village supply at Cottonwood yields a tremendous chlorine even for this district. The well is drilled 280 feet in blue clay and soapstone, whence the water comes. There is the usual closet within twenty-five feet. It would require a careful and exhaustive analysis to determine the question of purity of this water, which is located in a district yielding apparently both salt and nitrous acid naturally. No. 772 was taken from a drilled well, 192 feet deep. The soil and subsoil were not given, but are probably drift. No. 773 represents a surface water, and so presumably does No. 775.

YELLOW MEDICINE COUNTY.

Canby —From Marshall we turned northwest to Canby, and from there worked western Yellow Medicine and northern Lincoln counties. The Canby village well was formerly 500 feet deep, but has been filled to within 100 feet, in sand and clay. There was no evident contamination, and none hidden, according to the water-works man. Nos. 815, 816 and 818 were from shallow wells. Nos. 817, 819, 821 represent a series from Canby creek. As this small stream enters the town (represented by No. 821), it receives pollution (1) at the back of a livery barn from a huge pile of manure superimposed above the creek water; (2) a little further on, from a dump of stock-yard refuse, some 100 feet long and several feet thick (dumped by the railroad company on the side of the track just above the creek bank); (3) the dam near the creamery (represented by No. 819), which is constructed of manure and stone, and from it the Canby ice supply is cut; (4) further on from another dam (represented by No. 817), constructed similarly of rotten organic matter and stones. At this latter point, the supplementary ice supply for Canby is cut. These conditions the local health officer will endeavor to remedy. Nos. 822 and 823 represent flowing wells in clay and gravel, two miles southeast of Canby. No. 824 was taken from a spring three miles southeast of Canby. No. 825 was taken on the Lincoln county line from a driven well in clay, seventy-five feet; and sand, ten feet. The springs (represented by Nos. 826-828) are in north Lincoln county. Nos. 829 and 830 were taken from two (or rather three) excellent springs, some two to three miles south of Canby. There is a dearth of deep wells in this portion of the state, as most of the domestic supplies are from holes in the ground. Two popular drinking places in the village of Canby are represented

by Nos. 831 and 832. The waste water from the well represented by No. 831 ran into a mud hole at the side of the street, some ten feet from the well, and in it was a varied assortment of organic refuse,—animal and vegetable. No. 832 represents the drinking supply of the Le Sueur House, and is undoubtedly polluted by the hotel cesspool, some 100 feet distant. Both wells are dug in sand and gravel. The health officer promised to draw the attention of the village council to the condition of these waters. Going north from town, a sample was taken from a good flowing well, one and one-half miles out (No. 836). Four miles east of Canby a branch of the Lac qui Parle river showed contamination. Nos. 835, 838, 840, 842 and 844-846 represent waters from drilled wells along the road from Canby east by southeast, twenty-four miles. Of these drilled wells, some are unusual, and will be further considered under "Chlorine." No. 839 was taken from a large flowing well, in blue clay and hardpan. No. 843 represents a spring sample near No. 842.

Granite Falls.—The village has neither public waterworks nor sewerage system. The ice is cut from the Minnesota river, below the dam. A sample of the water was taken at a bridge near the center of the stream, at a point where ice is cut. Chemical examination, however, was in reality superfluous, as the numerous sources of filth were in plain sight. (1) For a distance of two blocks above the foot bridge dirty back yards drain into the river. (2) The outhouses appertaining to said yards are largely superimposed directly over the water. (3) A great pile of manure from a livery barn adds its quota to the above nasty mixture, and the whole, blended with the river water, forms the ice supply of Granite Falls (No. 856). The health officer has been endeavoring to induce the ice companies to cut above all this contamination, but thus far his efforts have been without avail.

Most of the private water supplies in the village are from dug wells, located with the usual disregard for sanitary conditions, and naturally polluted by the proximity of numerous sources of contamination. Consequently only a few samples were taken.

The water for the traveling public at the Hotel Du Nord is from a dug well, in an alley, and its environment is borne out by its analysis (No. 848). A similarly polluted water supplies the public school children (No. 850). Two other wells supply the public at large (Nos. 851 and 855). Nos. 849 and 852-854 were taken at the request of the local health officer. The last (No. 854) is used considerably by the neighborhood. Every one of these wells (Nos. 848-855) should be immediately closed.

Five miles northwest from Granite Falls an excellent spring sample was taken (No. 857), and another sample was taken one-

half mile further on from Stony Run creek (No. 858). Two drilled wells were sampled some six miles northwest (Nos. 859-860). Going south again along another road, a bored well sample was secured, on a high bluff, near the Minnesota river, two and one-half miles north of Granite Falls. This well was bored through yellow clay, twenty feet; sand, thirty feet; blue clay, ninety-five feet; and into the sand again. (No. 861). No. 863 represents another spring sample, taken one mile south of Granite Falls, on the road to Hanley.

Hanley Falls—The Hanley Falls village well is drilled some 250 feet, in blue clay, twenty feet, and the rest in sand and hardpan. Presumably this well reaches the "Sea Mud" (see chlorine), resting on the granite. Such wells apparently yield a high chlorine, and some nitrites and nitrates, in addition to free ammonia. On May 8, 1900, a sample from this well was sent to the laboratory, and condemned. In the light of even our present limited knowledge of the natural water in this part of the state, I should be inclined to modify this decision. The Yellow Medicine river was sampled near Hanley.

At WOOD LAKE the village well is 160 feet deep, with an outhouse sixty feet away. The water is undoubtedly from the drift, although no data were obtainable. The well is, however, chiefly for fire protection (No. 866).

At ECHO a dug well, sixty-five feet deep gave the lowest chlorine of the county, and probably represents the strictly surface salt (No. 868; chlorine .095). The village well is dug some six feet deeper than the well represented by No. 868, but it has seven times the chlorine. However, this is not used for drinking purposes. Echo has no sewerage system, and cuts its ice from the Minnesota river. Reference to the map will show that Echo is some miles southeast of Granite Falls, and the near point of the Minnesota river, where the ice cutting is done, is consequently below the pollution poured into the river from the aforesaid village. Many other towns pour pollution into, and cut ice from, the Minnesota river and its tributaries.

Southeast of Granite Falls, in the direction of Sacred Heart, a bored well and a spring were sampled (Nos. 870 and 871).

Sacred Heart.—The new water works were as yet unfinished, and we took merely a sample from the public well. It is a dug affair, in loam, clay and gravel, with condemning chemical data. No. 843 represents a dug-well sample, near Granite Falls.

LAC QUI PARLE COUNTY.

Dawson—The village well, dug ninety feet (represented by No. 874), we will examine more thoroughly at some future time, as its analysis was not satisfactory. South and southeast of Dawson a number of samples (Nos. 875-886), were taken from dug, driven or drilled wells, ranging in depth from twenty-four to 129 feet. These pass through loam and blue clay. Only one penetrates the rock (represented by No. 883),—blue clay, 126; rock, three feet. Most of them have the usual possible sources of pollution, which the blue clay is supposed to keep out, but the wide variance in the chemical data obtained suggested probable sand rifts in at least some cases. One of the samples was taken one mile south of the line, in Yellow Medicine county.

North and northwest the drift is apparently deeper, and the wells correspondingly so. Nos. 888, 889, 891, 894 and 895 were taken north and northeast of Dawson, and range in depth from 225 to 254 feet. Nos. 890 and 893 were from wells 185 feet deep, and No. 892 from a dug well, forty feet deep. All of these were given as passing through blue clay but no rock.

The Lac qui Parle river, at Dawson, is another "eyesore" example of rural sanitation. It is a dirty, weed-grown stream, about sixty feet wide, and about five feet deep. All the town rubbish is dumped along its banks. Three private sewers discharge their foul contents into its waters. A nasty stock yard stretches and stinks to the river's edge. Here refuse from the slaughter-house, including heads, entrails, etc., are fed to the hogs. A dirty livery barn has unceasingly dumped the manure from some twenty-four horses on the inclined shore, until a great mass has accumulated, the base of which is lapped by the Lac qui Parle waters. Several other piles of similar proportions and locations assist in the pollution; all of which does not include the numerous outhouses on the shore. This highly polluted river is then used as an ice supply for the town of Dawson! Furthermore, ice is shipped out of Dawson to supply the towns of Madison and Boyd. These conditions were presented to the consideration of the local health officer, and he thoroughly agreed with us as to the necessity for energetic measures. Unfortunately such measures would, without doubt, arouse the enmity of many people on whose patronage the doctor's very living depends, and it is too much to ask a man to sacrifice his practice and make endless enemies in the service of a community which does not appreciate his work. The doctor, therefore, requested action from the state, and the matter was referred to the secretary of the state board of health.

Madison—The soil and subsoil stratification in the vicinity of Madison was given by Mr. M. L. Mayland, well driller, as follows:

Loam	2 feet	"Sea mud,"	varying deposits;
Yellow clay	20 to 50 feet	Granite bottom.	
Blue clay	50 to 100 feet		

The fourth item, "sea mud," he describes as a fine gray clay, of varying thickness and salty taste. This deposit has been given its very appropriate name by well drillers of the vicinity. It apparently overlies the granite, and may account for the varying high chlorines of this part of the country. Mr. Mayland promised to send us samples of this mud when the next opportunity offered itself.

The Merchants' Hotel, in Madison, and the general public, patronize a dug well (represented by sample No. 896), some forty-eight feet in the drift and located in a dirty backyard, close to a "slop yard." The analysis naturally is unfavorable. Four miles north of Madison a well, forty feet deep, yielded a very high chlorine (No. 897). The high school well in Madison is a similar water, although not from quite so deep a well. Nos. 898, 899 and 901-905 were taken from tubular wells, ranging in depth from 100 to 180 feet, in drift. They do not presumably reach the sea mud.

Before leaving Madison finally a few other samples were taken in the town. No. 919 was taken from the courthouse tubular well, which passes through 185 feet of drift, and is removed from sources of pollution. However, at the time of our visit the authorities were digging a cesspool thirty-six feet from the well. We endeavored to deter them from inevitably polluting a very good water, but our representation being merely advisory, it had no effect, and the cesspool is probably by this time doing its work. No. 931 was taken from the town driven well, 125 feet deep, with no objectionable environment. At present it is used by the creamery and electric light plant, and is the probable future Madison supply. Nos. 920 and 923 represent two dirty dug wells, of which the latter supplies the bedrooms of the Merchants Hotel. No. 922 was taken from a spring ten feet from the hotel closets, and of course, shows the effects of its environments. We examined it merely to demonstrate its condition.

Marietta—For the sake of the chlorine a number of samples of water were taken in Marietta and environing country, up to the Dakota border. Four miles southeast the Lac qui Parle river yielded a high river chlorine (No. 906), which is probably not due to pollution. The most interesting body of water as yet encountered during this chlorine survey is the Salt Lake of Lac qui Parle county. Our state maps did not mention it, but the name appears upon some of the railroad fishing guide maps. Located some four miles south-

west of Marietta, and very near the Dakota line, it lies in a depression of the drift,—a small, apparently shallow, pond in the mud and gravel, with no habitation nearer than half a mile, and neither outlet nor inlet visible. On approaching the water two peculiarities of this lake are immediately manifested. Reaching back from the edge, some fifty feet, the gradually sloping shore glistens with white incrustations of inorganic salts, and as the water is reached the strange anomaly of a Minnesota drift lake with no vegetation presents itself. The taste of this water is distinctly saltish, and the analysis yielded the first extremely high chlorine in a Minnesota lake water (184 parts per 100,000). Beyond Salt lake, to the southwest six and one-half miles, and then returning to Marietta by another road, one mile east, a number of high chlorine flowing wells were found (Nos. 909-915). This series of flowing wells extends into the Dakotas. Nos. 916 and 917 represent presumably polluted waters. No. 917 was taken from the Marietta town pump,—a dug well located on a back street.

Bellingham—This village has no sewerage system, and its wells are chiefly shallow. We were requested to examine samples from these and from the ice supply, in the laboratory, and sample bottles will be sent. One mile south of Bellingham a tubular well sample was taken. This well passes through 140 feet of yellow clay and blue clay to the sand, but there is a barn within forty feet, and the analysis was satisfactory.

INCIDENTAL VISITS.

Belle Plaine—By request of the local health officer, I stopped at Belle Plaine to inspect the village tank. It was an ancient, leaking, wooden affair, fast succumbing to decay. Personal inspection was followed by chemical analysis of the water direct from the well, and likewise from the tank. Constant use kept said tank supplied with fresh water, so that the difference in analytical data shows the effect on the water of only a few hours' standing (Lab. Anal. Nos. 494 and 495).

Three other samples were taken in the village. The railroad well at Belle Plaine consists practically of two wells. The pipe was first put down 106 feet, when they struck the salty water, which was the cause of the salt agitation in 1870-72 (No. 787; chlorine 66 parts). The second well is sixty-six feet deep. The water obtained by drawing the pipe up some forty feet. This was done two weeks before the date of our visit, but we were able to obtain a sample of the old well from water standing in the cistern. This cistern was built in the ground, directly over the wells, and receives some leak-

age from the pipes of the well, which is sixty-six feet deep. Consequently the sample (No. 787) is not from the well which is 106 feet deep, but a mixture of both supplies. No. 788 is direct from the pipes of the more shallow well. Laboratory analyses Nos. 94 and 98 are from these Belle Plaine waters. No. 789 is from the so-called "salt springs," but either the title is a misnomer or the salty water has been deflected from the spring, as its chlorine is merely a surface quantity.

The well drilled in Belle Plaine, in accordance with an act of the legislature of 1870, is some 710 feet deep, but the pump has been taken off and the pipes plugged up. It would have been possible to remove the plug and put in a pump, but it seemed unnecessary, as we had positive information that considerable salt was taken out for commercial purposes. This part of the state needs careful investigation, as the salt seems to be in both deep and shallow waters. The strata of the well 710 feet deep is as follows:

Drift	216 feet	Semi-igneous	108 feet
Sandstone	16 feet	Red shale	6 feet
Shale	10 feet	Igneous	314 feet
Soapstone	40 feet		

Montevideo—The water of this village was incidentally examined while I was at the place on other business. The village draws its water supply from seven dug and driven wells, which pass through from twelve to twenty-four feet of quicksand and from twelve to eighteen feet of clay, thence into the gravel. The variation of figures represents the variety of data obtained from the different local authorities. These wells are about forty feet deep in the drift, and are located on the banks of the Chippewa, amid a most undesirable environment of barns, closets, etc. Furthermore, the village of Montevideo is plotted on the steep side of the river gorge and on the high overlooking plateau. Natural drainage thus passes from a great series of polluting sources on toward the river and toward the wells. The sample (No. 796) was taken from a tap in the Riverside Hotel. Later laboratory analyses were made of this supply, which add to the condemning data, and furthermore show a marked variation, which is of itself the strongest evidence of pollution (Lab. Anal. Nos. 640 and 661). As a part result of this investigation, water from a series of twelve wells was sent to the laboratory for examination. These will be treated under "Laboratory Analyses." No. 797 was taken from a dug well a short distance from the waterworks Nos. 798, 800, 805, 806 and 809 were taken from shallow wells in or near the town. They have the usual sources of pollution, which account for their analyses. One of them (No. 806) is from the school-house well; another (No. 805) is from a

popular street drinking place. No. 799 was taken from a little granite bedded lake, shaped like an elongated half moon. One farmhouse is on its shore. No. 801 was taken from a spring (in modified drift and granite) which is located on a hillside, in a grove, with good environment. The Minnesota river was sampled some three and one-half miles southeast of Montevideo. At the point of sampling it was about two feet deep and 200 feet broad (No. 802). No. 803 was taken from a spring on the shore of Black Oak lake, some five miles northeast of Montevideo. The drive was made to secure a sample of this lake, which is described in the Geological Survey as a large body of water. However, it is now practically a great swamp, covered with rank vegetation. Its chlorine is probably due to animal causation. Nos. 807 and 808 were taken from two springs in Montevideo. No. 810 was from a drilled well, 110 feet deep, in sand, clay and granite, located on the high prairie level. No. 811 represents the Chippewa river, near the waterworks, where it receives much drainage. The depth of the Windom institute well (No. 812) we did not ascertain. Further consideration of a number of the waters included in the foregoing "Report by Counties" will be found under the heading "Chlorine."

FIELD ANALYSES.

ANALYTICAL DATA IN PARTS PER 100,000.

Number.	Location.	Where Taken.	Chlorine.	Nitrates.	Nitrites.	Consumed Oxygen.	Alkalinity.	Depth.	Hardness.
1	Luverne	Town well.................	.82	Dist'ct	Absent	.299	12.0	20	......
2	"	Rock river..................	.208	Trace	Dist'ct	.806	10.0	3	......
3	"	Burlington depot..........	2.7	Strong	Absent	.44	20.0	15	......
4	"	Court house	1.04	Dist'ct	"	.161	30.0	35	......
5	"	J. C. Johnson's.............	.728	Strong	"	......	10.0	22	......
6	"	Skang's	5.6	Trace	"	......	......	20	......
7	"	H. G. Nelson's.............	1.5	Dist'ct	Trace	.20	......	15	......
8	"	Near high school	10.1	"	Strong	......	......	20	......
9	"	Bark's......................	14.7	"	Trace	......	14.0	15	......
10	"	G. L. Alder's	3.2	Absent	"	......	......	20	......
11	"	Snook's	10.3	Dist'ct	"	.44	......	35	......
12	"	Pring's......................	2.7	"	Absent	......	......	20	......
13	"	Ryan's	3.64	"	"	......	20.0	......	......
14	"	Dave Beer's................	3.7	"	Trace	.26	......	......	......
15	"	J. O. Larson's..............	12.1	"	Dist'ct	......	......	......	......
16	"	Geo. Roberts'..............	9.152	"	Trace	......	......	18	......
17	"	Ben Dodge's	3.7	Trace	Dist'ct	.54	12.0	20	......
18	"	R. B. Hinkley's............	4.24	Dist'ct	Trace	......	......	22	......
19	Hardwick....	F. P. Panston's	8.84	"	Dist'ct	......	......	60	......
20	"	Bank well...................	.208	Absent	Absent	.69	14.0	40	36
21	"	J. B. Irish's	2.04	Dist'ct	Mark'd	......	......	60	......
22	"	J. Hough's	3.54	"	Trace	......	......	47	......
23	"	J. Menard's................	.728	"	Strong	......	......	20	......
24	"	E. T. Thorsen's...........	.208	Absent	Absent	.54	10.0	150	26
25	"	Irving Smotel's...........	.208	"	"	.24	10.8	110	......
26	Beaver Creek	Town well..................	1.55	Mark'd	Mark'd	......	12.8	65	30
27	"	Depot well.................	3.95	....	Trace	......	......	35	......
28	"	Hotel well	5.2	Mark'd	Mark'd	......	......	30	......
29	"	Marshall's well...........	.728	"	Dist'ct	......	14.0	100	36
30	"	Beaver creek	.208	Absent	Absent	......	12.0	2	......
31	"	Grout's	2.08	Strong	Trace	......	......	90	......
32	Luverne	Three miles west..........	.624	Dist'ct	"	......	14.0	12	36
33	"	Hinkley's Mound farm....	.208	Trace	Dist'ct	.44	4.0	163	21.2
34	"	Mound creek spring.......	.312	"	Absent	.24	......	......	......
35	"	Mound creek...............	.208	Absent	"	.68	8.0	10	......
36	Hardwick r'd	T. O. Tollefson's spring...	.208	Sm. trace	"	.46	8.0	......	......
37	"	C. Mannigal's spring......	.208	Trace	"	.24	......	......	......
38	Hardwick....	Hinkley's well............	.624	Dist'ct	Trace	.32	8.0	80	19.2
39	"	J. Wright's well..........	.62	"	"	.44	8.0	358	......
40	Luverne	Mr. Ronald's	4.4	"	"	......	......	......	......
41	Adrian.......	Town well..................	.312	S.trace	Absent	.201	12.0	47	37
42	"	Hess' deep well............	.52	Absent	"	.606	18.0	90	......
43	"	Hess' shallow well.........	.83	Slt. trace	"	......	......	26	......
44	"	Dr. Sullivan's well	.312	Absent	"	.46	14.0	225	......
45	"	Swanman's well........ ..	.312	"	Mark'd	.64	14.0	158	......
46	"	Roadside well..............	.312	Trace	Absent	.46	10.0	......	......
47	"	Hargle's house well........	7.5	Dist'ct	Dist'ct	......	......	24	......
48	"	Hargle's bored well	.52	Absent	Absent	.201	12.0	120	......
49	"	Thon's well	.312	"	"	.24	10.0	197	......
50	"	Slade's spring	.208	"	"	.25	12.0	......	......
51	"	Spring near railroad	.208	"	"	.25	......	......	......
52	Worthington	Town supply	.936	Strong	Trace	.24	10.0	......	......
53	"	Crandall's..................	.936	Dist'ct	S.trace	.32	......	75	......
54	"	Swanakall's................	7.1	V. st'rg	Strong	......	......	15	......
55	"	G. R. Anderson's..........	1.04	Slt. trace	S. trace	.74	8.0	14	27
56	"	Kendalin's..................	9.1†	Strong	Strong	......	......	......	......
57	"	Goodrich's	.52	S. trace	S. trace	.14	10.0	30	......
58	"	F. Lyon's	6.2†	Distinct	"	......	......	30	......
59	"	F. Lyon's drilled well.....	1.04	"	Strong	......	10.0	90	......
60	"	Edward's deep well	.728	Absent	Absent	.3	12.0	155	......
61	"	Edward's shallow well....	4.5	Distinct	Trace	.28	6.0	16	......
62	"	P. Peterson, 3 miles south	.832	Marked	"	......	......	84	......
63	"	Senator Shell's	.208	Absent	S. trace	.38	......	15	......
64	"	J. Nelson's, 1 mile S. E....	.624	Strong	Strong	......	......	......	......
65	"	Lake Ocheda, 3 miles south	.208	Absent	Absent	1.28	2.0	......	......
66	Adrian.......	Kanaranzi river...........	.208	"	Distinct	.705	8.0	......	......

† Plus.

FIELD ANALYSES—*Continued.*

Number.	Location.	Where Taken.	Chlorine.	Nitrates.	Nitrites.	Consumed Oxygen.	Alkalinity.	Depth.	Hardness.
67	Worthington	Lake Okabena	.208	Absent	Absent	.58	6.0	......	......
68	"	Shallow town well	1.7	Strong	Distinct	.5	......	15	......
69	"	Left shallow town well	1.3	Distinct	Absent	.38	6.0	15	......
70	"	Artesian town well	.208	Absent	"	.22	16.0	75	......
71	"	Round Lake	.208	"	"	1.2	6.0	......	......
72	Round Lake	Town well	.624	"	S. trace	.24	......	16	......
73	"	Depot well	6.24†	Strong	V. strong	......	......	10	......
74	Jackson	Des Moines river	.208	Absent	Absent	1.27	......	......	......
75	"	Town well	.52	Distinct	"	.201	8.0	18	......
76	"	Iverson's	3.12†	"	Distinct	......	......	20	......
77	"	Railroad bridge spring	.312	Trace	Absent	.18	8.0	......	......
78	"	O. K. Moarland's	.624	Marked	"	......	......	26	......
79	"	Nagel's	3.12†	"	Marked	......	......	......	......
80	"	John Burnham's	.936	Strong	Strong	......	......	18	......
81	"	Mrs. Paddock's	6.24†	Distinct	Distinct	......	......	50	......
82	"	Henry Strom's	.832	"	Marked	......	......	22	......
83	"	H. G. Egstein's	1.04	Trace	"	......	......	25	......
84	"	Egstein's, 9 miles south	.208	Absent	Absent	.26	12.0	33	......
85	"	Wm. Gruhlke's, 6 miles S.	.208	"	"	......	......	60	......
86	"	Frank Krause's	.312	"	"	.24	12.0	229	......
87	"	J. C. Eddling's	3.12	Marked	Trace	......	......	26	......
88	"	F. Sawyer's	3.12	Strong	Marked	......	......	112	......
89	"	Geo. E. Tie's	3.12†	"	Strong	......	......	80	......
90	"	Eddling's	.208	Trace	Distinct	......	......	60	......
91	Prairie Jct.	Depot	3.12†	Distinct	"	......	......	112	......
92	Sherburne	C. L. Coleman's	3.12†	"	Trace	......	......	......	......
93	"	Chas. Meyer's	1.976	Marked	Absent	......	......	......	......
94	"	Alliance Mill	.208	Absent	"	.28	14.0	123	......
95	"	W. M. Master's	3.12†	Strong	Distinct	......	......	26	......
96	"	A. W. Deane's	2.704	Marked	Absent	......	......	28	......
97	"	Jurries'	1.456	"	"	......	......	75	......
98	"	Fox Lake, 1½ miles east	.208	Absent	"	2.28	6.0	......	60
99	"	Town supply	.312	"	"	.32	10.0	200	......
100	Fairmont	Budd Lake, town supply	.312	"	"	1.52	3.0	......	39
101	"	Lake Sisseton	.312	"	Trace	3.08	4.0	......	......
102	"	Frank Johnson's	.208	"	Absent	.24	14.0	112	......
103	"	Meyer Bottling Co.'s	3.12†	Distinct	Trace	......	......	25	......
104	"	Meyer Bottling Co.'s deep	.312	Absent	Absent	......	......	136	......
105	"	Alley well	.208	"	"	......	......	......	......
106	"	Fairmont, 2 miles north	3.12†	Marked	Marked	......	......	......	......
107	"	Anderson's	.312	Absent	Absent	.20	......	80	......
108	"	Pearl Mattson's	2.496	Marked	Distinct	......	......	40	......
109	"	F. A. Patterson's	.312	S. trace	Absent	.34	......	......	......
110	"	A. H. Smith's	2.392	Distinct	Distinct	......	......	66	......
111	"	C. M. Peterson's	.208	S. trace	Absent	......	......	80	......
112	"	Dr. McCann's	1.872	Strong	Trace	......	......	16	......
113	"	B. H. Ward's	.312	Absent	Absent	.20	......	60	......
114	"	Phiffer's	.208	"	"	......	......	......	......
115	"	Sinclair's	1.352	Distinct	Marked	......	......	......	40
116	"	Lieut. Gov. Day's	.208	S. trace	Absent	.24	14.0	70	40
117	"	Bullard's	1.352	Strong	Distinct	......	......	130	......
118	Winnebago C.	Town well	.312	S. trace	Absent	.18	12.0	266	......
119	"	Blue Earth river	.208	Distinct	S. trace	.80	6.0	......	20
120	"	Pierce's	.312	Absent	Absent	.20	14.0	50	35
121	"	Ed. Gwynn's	.624	"	"	.18	12.0	27	......
122	"	C. Jackson's	3.12†	Strong	Trace	......	......	......	......
123	"	Ring's	3.12†	Marked	Absent	......	......	80	......
124	"	J. A. Armstrong's	.208	Absent	"	.16	13.2	110	......
125	"	Public street well	3.12†	Strong	Trace	......	......	100	......
126	"	McGingan's	3.12†	Marked	Marked	......	......	75	......
127	"	A. H. Weed's	2.08	"	Trace	......	......	100	......
128	"	Baxter's	3.12†	"	Marked	......	......	60	......
129	"	R. Johnson's, 6½ mi. S. W.	.208	Absent	Absent	.22	12.0	......	......
130	Blue Earth C.	Town well	.312	"	"	.36	14.0	1240	41
131	"	Tap at public fountain	.312	"	"	.22	......	......	......
132	"	C. M. Sly's	3.12†	Strong	S. trace	.54	......	35	......
133	"	H. McDonald's	3.12†	"	Trace	.36	......	35	......
134	"	Kaupp's	3.12†	"	Marked	.34	......	35	......
135	"	Chadwin's	.312	Absent	Absent	.22	14.0	165	......
136	Wells	Town well	.312	"	"	.20	......	300	26
137	"	Milwaukee railroad well	.416	"	"	.28	......	114	33

† Plus.

FIELD ANALYSES—*Continued.*

Number.	Location.	Where Taken.	Chlorine.	Nitrates.	Nitrites.	Consumed Oxygen.	Alkalinity.	Depth.	Hardness.
138	Wells........	Anderson's................	.208	Absent	Absent	.20	......	100	......
139	"	J. B. Burke	.208	"	"	.22	......	118	30
140	"	W. B. Movery's...........	.208	"	"	......	......	......	......
141	"	Judge Quinn's..............	.208	"	"	.22	......	......	29
142	"	Slough water.............	1.14	Strong	Strong†	.46	......	......	......
143	"	Ellickson's................	.312	Absent	Absent	.30	......	......	......
144	"	Park Hotel tap	.208	"	....	.20	......	......	......
145	Alden	Town well..................	.208	"	Absent	.26	16.0	100	27
146	"	Tap water	.208	"	"	......	......	......	......
147	"	Public well................	.208	"	"	.14	14.0	160	26
148	"	Drown's	3.12†	Marked	Marked	......	......	50	......
149	"	Mattison's	3.12†	Distinct	Absent	......	14.0	40	41
150	"	Gem Lake..................	3.12†	Absent	"	......	6.0	7	......
151	Albert Lea...	Town supply...............	.208	"	"	.16	16.0	650	27
152	"	Old town well	.208	"	"	.08	12.0	300	28
153	"	D. Colvin's................	.208	Distinct	Distinct	.10	12.0	......	......
154	"	Drummer House	3.12†	Strong	Trace	......	10.0	35	......
155	"	Todd Prentice's...........	.208	Absent	Absent	......	......	150	......
156	"	Dr. Blackmore's..........	.208	"	"	.08	12.0	......	......
157	"	City tap at Dr. Blackmore's	.208	"	"	.22	......	......	......
158	"	Fountain Lake............	.312	Distinct	Trace	1.88	6.0	......	......
159	"	Fountain Lake, near livery	.416	Marked	Distinct	1.96	......	......	......
160	"	Flowing artesian..........	.208	Trace	Trace	......	10.0	......	......
161	"	Martlett's	.208	Absent	Absent	......	13.2	147	38
162	"	Gardner's..................	2.91	Strong	Distinct	......	10.0	12	30
163	"	Drain water	6.24†	"	Strong	1.8	......	......	......
164	Oakland......	G. D. Frisby's.............	3.12†	V. strong	Absent	.306	6.0	40	......
165	"	Town pump................	.208	Absent	"	.326	12.0	100	......
166	"	Peterson's..............	3.12†	V. strong	Strong	......	10.0	42	......
167	"	T. J. Fogarty's............	3.12†	"	Trace	.408	6.0	42	......
168	Austin	Mixed city supply.........	.624	Distinct	Absent	.37	8.0	600	......
169	"	Mixed city supply, shallow	1.976	Marked	"	.24	6.0	135	......
170	"	East shallow well..........	1.976	"	"	......	6.0	135	......
171	"	West shallow well.........	1.664	"	"	......	6.0	135	......
172	"	Sargent's spring, 3 miles E.	.208	Trace	"	......	8.0	......	......
173	"	Silome spring, No. 1.......	.208	Absent	"	.08	6.0	......	28
174	"	Silome spring, No. 2.......	.208	"	"	......	8.0	......	......
175	"	Dr. Robin's	4.16†	Marked	"	.32	6.0	25	......
176	"	McCourt's.................	3.12†	Strong	Distinct	......	2.0	28	......
177	"	S. D. Caterwood's	2.08	"	Absent	.16	4.0	16	......
178	"	Cedar river, at railroad...	.512	Marked	Marked	.77	2.0	200	31
179	"	Dobbin's creek............	.268	Distinct	S. trace	......	6.0	......	......
180	"	Saxie's spring.............	.312	"	Absent	.16	......	......	......
181	"	Herzog spring.............	.208	"	"	.29	......	......	......
182	"	Graveyard spring.........	.312	Absent	"	.48	......	......	......
183	"	City ice	.208	Trace	Trace	2.03	......	......	......
184	"	Cedar river at graveyard..	.416	Distinct	Distinct	1.39	......	......	......
185	Gr'd Meadow	Town pump................	3.12†	Strong	Trace	.60	......	70	......
186	"	Greening's Bank..........	1.70	Absent	Absent	.40	10.0	84	......
187	"	Greening's house well.....	.728	"	S. trace	.26	8.0	75	36
188	"	Deer creek, 1¼ miles east..	.208	Marked	Distinct	.82	4.0	......	19
189	"	Ice from Deer creek.......	.832	"	"	......	......	......	......
190	"	Spring on Deer creek......	.208	Strong	Absent	.27	8.0	......	......
191	"	Lockwood's................	1.70	"	"	.23	10.0	22	......
192	Spring Valley	Town spring...............	.312	"	"	.29	6.0	......	29
193	"	Town well.................	.728	"	"	.31	6.0	15	......
194	"	High school...............	2.30	"	"	.36	8.0	72	......
195	"	Graded school.............	.936	"	Trace	.23	6.0	54	......
196	"	Schell's....................	2.08	"	Distinct	......	8.0	50	......
197	"	Lawrence's	3.12†	"	Trace	.63	6.0	22	......
198	"	Old town well	3.12†	"	Absent	......	8.0	20	......
199	"	T. O. Kelbourne's.........	2.08	"	Marked	......	5.0	48	40
200	"	Bowden's	.728	Marked	Trace	......	8.0	103	......
201	"	Railroad well.............	1.8	Strong	Absent	.31	8.0	15	......
202	"	Strong spring, 1 mile east.	.520	Marked	"	......	......	......	......
203	"	Melted ice.................	.208	Trace	S. trace	.96	2.0	......	......
204	"	Molstad's..................	1.456	Marked	Distinct	......	8.0	50	......
205	Fountain	Town well.................	.208	S. trace	Absent	.27	8.0	586	38
206	"	Town well, No. 2..........	.208	Absent	"	.24	8.0	389	......
207	"	Town well, No. 2, cistern..	.208	"	S. trace	.27	8.0	......	......
208	"	Cistern near grain office..	.208	"	Absent	.29	8.0	......	......

† Plus.

FIELD ANALYSES—*Continued.*

Number.	Location.	Where Taken.	Chlorine.	Nitrates.	Nitrites.	Consumed Oxygen.	Alkalinity.	Depth.	Hardness.
209	Fountain	Cistern center of town....	.208	Absent	Absent	.27	8.0	......	......
210	Preston	Town supply..............	.208	Marked	"	.27	6.0	......	42
211	"	Ice from Root river........	.208	Absent	"	.30	1.0	......	......
212	"	R. W. Rockwell's..........	3.12†	Strong	Trace	.30	12.0	28	......
213	"	Viall's	3.12†	"	S. trace	.23	10.0	48	51
214	"	A. D. Gray's	.832	"	Strong	......	8.0	100	......
215	Lanesboro'gh	Town spring	.208	Absent	S. trace	.53	8.0	......	41
216	"	Silvan Park Spring........	.936	Distinct	Absent	......	8.0	......	......
217	"	Town street well..........	3.12†	Marked	S. trace	......	10.0	67	......
218	"	Town well on bluff........	.312	Absent	Absent	.24	6.0	250	30
219	"	Henderson's	1.872	Strong	"	......	8.0	......	......
220	"	Ben Evenson's.............	1.456	"	"	......	8.0	15	......
221	"	Creamery well.............	2.808	"	S. trace	......	8.0	14	......
222	"	Root river, at bridge......	.812	Marked	Distinct	.43	6.0	......	34
223	"	Valley House well.........	2.392	Strong	"	......	8.0	54	......
224	"	Merchants Hotel	.832	"	Absent	.22	8.0	45	40
225	"	Ice from mill pond	.208	Absent	"	1.54	1.0	......	......
226	Rushford.....	Town well..................	1.04	S. trace	"	.10	8.0	285	36
227	"	Town tap..................	.624	....	"	......	8.0	......	......
228	"	Town pump................	5.40	Strong	Distinct	......	10.0	30	......
229	"	Dr. Maggelson's...........	.624	S. trace	S. trace	.52	14.0	60	......
230	"	Root river, at bridge......	.208	Trace	Distinct	......	6.0	......	......
231	"	Railroad well..............	2.08	Strong	Marked	......	12.0	40	......
232	"	Ice from Rush creek	.312	Absent	Absent	.12	1.0	......	......
233	Caledonia....	Town well..................	1.30	Strong	"	.16	6.0	300	30.8
234	"	Old town pump............	9.90	"	"	......	14.0	82	......
235	"	J. Vossen's...	14.7	"	"	......	12.0	68	......
236	"	Jail well...................	9.90	"	S. trace	......	10.0	60	......
237	"	Peter Schmitt's............	.312	Marked	Absent	......	6.0	317	......
238	Sheldon	Beaver creek	.312	Distinct	S. trace	......	7.0	......	32
239	"	Oberland's	.312	Marked	Absent	......	10.0	40	......
240	Houston......	Windsor Hotel.............	3.12†	....	Marked	......	......	17	......
241	"	Benson's artesian§.........	9.88	Absent	Absent	.40	8.0	248	......
242	"	Porter's artesian	13.94	"	"	.30	6.0	260	......
243	"	Forsyth's artesian.........	13.94	"	"	.23	6.0	300	......
244	"	Amidon's artesian	15.39	"	"	.23	6.0	260	......
245	"	Dyer & Grasby's artesian	17.2	"	"	.27	8.0	310	......
246	"	J. A. Johnson's artesian...	15.39	"	"	.27	......	......	......
247	"	School house artesian.....	15.39	"	"	......	......	280	......
248	"	G. W. Waiste's artesian...	16.10	"	"	......	......	280	......
249	"	Buell's bank artesian......	12.10	"	"	.16	......	260	......
250	"	McCann's artesian.........	6.75	"	"	.12	......	240	36.8
251	"	Ben Grasby's artesian.....	16.1	"	"	......	......	300	......
252	"	M. J. Taylor's artesian....	15.39	"	"	.23	......	256	......
253	"	McMillan's artesian.......	15.39	"	"	.23	......	275	......
254	"	P. R. Field's artesian......	12.10	"	"	.12	......	245	......
255	"	Chappel's artesian.........	5.5	"	"	......	......	240	......
256	"	Creamery artesian	5.25	"	"	......	......	236	30
257	"	Old mill artesian	9.36	"	"	.16	......	240	......
258	"	Brunswick Hotel..........	6.24	"	"	......	......	285	......
259	"	Pete Peterson's artesian..	9.1	"	"	......	......	255	......
260	"	Rowland's artesian........	9.1	"	"	.10	......	290	......
261	"	Coon's artesian............	5.47	"	"	......	......	......	......
262	"	Harvey Harris' artesian...	4.42	"	"	......	......	230	......
263	"	Dyer's artesian............	10.96	"	"	.12	......	300	......
264	"	T. O'Connor's artesian....	10.40	"	"	......	......	......	......
265	"	K. Grasby's artesian......	18.72	"	"	.10	......	339	......
266	"	J. R. Gordon's artesian...	10.96	"	"	......	......	265*	......
267	"	A. P. Johnson's artesian ..	13.31	"	"	......	......	275*	......
268	"	J. T. Onstad's artesian....	12.06	"	"	.16	......	260*	......
269	Houston......	A. Johnson's artesian......	2.6	"	"	......	......	250	......
270	"	Rank's artesian............	6.24	"	"	......	......	260	32
271	"	Magnison's artesian.......	1.82	"	"	.12	......	290	......
272	"	Hemstad's artesian........	2.60	"	"	......	......	256	......
273	"	K. Blackman's.............	2.08	"	"	......	......	300	......
274	"	Brigg's artesian...........	1.82	"	"	......	......	300	......
275	"	Anderson's artesian	1.30	"	"	.09	......	335	......
276	"	Longen's artesian.........	2.86	"	"	......	......	325	......
277	"	Stromme's artesian	1.04	"	"	.11	......	......	......
278	"	Johnson's artesian.........	1.04	"	"	......	......	300	32
279	"	Daley creek................	.208	Trace	"	......	......	......	......

† Plus.
* The depth of Nos. 266-268 were given as "probable" and "about."
§ The word artesian is here used in its popular sense of a flowing well.

FIELD ANALYSES—*Continued.*

Number.	Location.	Where Taken.	Chlorine.	Nitrates.	Nitrites.	Consumed Oxygen.	Alkalinity.	Depth.	Hardness.
280	Houston......	Hovde's artesian..........	.312	Absent	Absent	......	......	415	......
281	"	Spring....................	.416	"	"	.09	......	......	......
282	"	Ole Erickson's............	.312	"	"	......	......	135	......
283	"	Halvorsen's artesian	.208	"	"	......	......	150	......
284	Rushford.....	Spring, 3 miles N. E.......	.208	Marked	"	.....	......	333	......
285	Rushf'd to Houston	J. Fine's, 3 miles N. by N.E.	.312	Absent	"	......	......	......	27.6
286	"	Rush creek................	.312	"	Trace	.27	......	......	......
287	"	Martin's, 4 miles N. E.....	.624	"	....	.14	......	350	......
288	"	A. Ronneberg's, 4½........	.312	S. trace	Absent	......	......	350	......
289	"	Mike Miller's, 5 miles N. E.	.312	Absent	"	......	......	320	......
290	"	R. McCormick's............	.312	Trace	Trace	......	......	300	......
291	"	W. Tracy's	.312	S. trace	Absent	......	......	340	......
292	"	Money creek...............	.312	Distinct	S. trace	......	......	......	......
293	"	W. F. Todd's	.312	....	Absent	.22	......	150	......
294	"	S. H. Robinson's artesian..	1.75	Absent	"	.22	......	325	......
295	"	S. H. Robinson's cattle well	2.75	"	"	.16	......	200	......
296	"	Dave Robinson's...........	14.04	"	"	.30	......	440	......
297	"	Forsythe's	1.75	"	"	......	......	295	35.2
298	"	Jno. Ryder's artesian......	3.90	"	"	.18	......	362	......
299	"	Perkins' artesian..........	14.04	"	"	......	......	420	36.8
300	"	A. Holt's artesian	3.90	....	"	......	......	265	......
301	Houston to Hokah.	Root river, south fork	.88	....	....	......	......	......	......
302	"	H. Holmes' artesian.......	16.90	....	....	......	......	......	......
303	"	Nic. Redding's artesian...	13.50	....	....	......	......	160	......
304	"	J. B. Anderson's artesian..	5.72	....	....	......	......	210	......
305	"	Nels Anderson's artesian..	6.24	....	....	......	......	150	......
306	"	J. A. Vervat's artesian....	7.80	....	....	......	......	272	......
307	"	Yelden's, drilled..........	.88	....	....	......	......	400	......
308	"	Chas. Arnett's artesian ...	.88	....	....	......	......	390	......
309	"	J. Orr's artesian..........	.312	....	....	......	......	80	......
310	"	F. Burrows'...............	.650	....	....	......	......	300	......
311	"	Carl Pivek's	1.04	....	....	......	......	310	......
312	"	J. A. Eberhard's..........	1.82	....	....	......	......	120	......
313	"	C. Lehmann's.............	.312	....	....	......	......	280	......
314	"	J. Schild's artesian........	.90	....	....	......	......	297	......
315	"	Lufe's artesian	.312	....	....	......	......	296	......
316	"	H. P. Pilger's artesian.....	.312	....	....	......	......	......	......
317	"	Hokah town well, artesian	.728	Absent	Absent	.001	9.0	544	40.8
318	Hokah to Houston.	Hargrave's springs........	.416	....	....	......	......	......	......
319	"	T. Lynch's artesian........	.312	....	....	......	......	325	......
320	"	Shelden's tubular..........	.312	....	....	......	......	105	......
321	"	G. Arnet's tubular.........	.312	....	....	......	......	169	......
322	"	Eberhard's drilled.........	.312	....	....	......	......	110	......
323	"	Silver creek...............	.312	....	....	......	......	......	......
324	"	C. Nelsen's artesian.......	6.76	Absent	Absent	......	......	250	......
325	"	Ed. Amidon's artesian.....	22.67	"	"	......	......	300	......
326	"	Thompson's artesian......	1.87	"	"	......	......	250	......
327	"	Forsythe, Looney Valley..	.312	"	"	......	......	......	......
328	"	F. Peterson's artesian.....	5.61	"	"	......	......	......	......
329	"	Devers' artesian..........	15.60	"	"	......	......	208	......
330	"	Mike Kelley's artesian....	12.27	"	"	......	......	241	......
331	Houston to Yucatan	Chas. Anderson's artesian	1.82	....	....	......	......	316	......
332	"	Nels Murkey's artesian....	11.44	Absent	Absent	.11	8.0	230	34
333	"	Mrs. Moon's, drilled.......	1.95	....	....	......	......	110	......
334	"	Ole Eliasson's artesian....	1.24	Trace	S. trace	......	8.0	360	......
335	"	L. O. Weam's artesian.....	.728	Absent	Absent	......	8.0	300	......
336	"	McMillan's artesian.......	3.25	....	....	......	......	390	......
337	"	G. Onstad's spring.........	.312	Distinct	Absent	.051	8.0	......	36
338	"	P. T. Brevig's spring	.312	"	"	......	8.0	......	......
339	"	H. Carriers', drilled.......	.520	"	"	......	8.0	100	......
340	Yucatan to Houston	J. O. Norskog's, drilled....	.312	....	"	.051	8.0	338	33.6
341	"	John Eliasson, drilled.....	.416	....	"	......	8.0	338	34.4
342	"	M. Christianson's artesian	2.34	Absent	"	.08	6.0	300	......
343	Money creek.	Toston Olson's artesian....	.78	"	"	......	......	325	......
344	"	Wm. Ornot's artesian.....	.78	"	"	.10	......	320	......
345	"	Knute Ornot's, drilled	.416	"	"	.14	8.0	420	33.2
346	"	Louis Ornot's artesian	3.40	"	"	.10	8.0	400	37.2
347	Nr. Houston.	Fraumkon's artesian......	13.52	"	"	......	8.0	306	......
348	Houston to Sheldon	H. Abramson's drilled.....	4.16	....	"	.16	8.0	380	35.2
349	"	Tory Anderson's, drilled ..	3.12	Absent	"	......	8.0	100	......
350	"	Aminson's artesian........	3.72	"	"	.10	8.0	380	32.8

† Plus.

FIELD ANALYSES—*Continued.*

Number.	Location.	Where Taken.	Chlorine.	Nitrates.	Nitrites.	Consumed Oxygen.	Alkalinity.	Depth.	Hardness.
351	Houston to Sheldon	K. Vattung's artesian	.650	......	......	......	......	275	......
352	"	Andrew Lee's artesian	3.64	......	......	......	......	400	......
353	"	Tolf Scrui's, drilled	.312	......	......	......	......	114	......
354	"	A. L. Vraa's drilled	.312	......	......	......	......	180	......
355	"	Weom's homestead	.312	......	......	......	......	85	......
356	"	Knute Halvorsen's	.416	......	......	......	......	372	......
357	"	Paul Paulson's	.312	......	......	......	......	100	......
358	"	C. Hanson's	.416	Strong	Absent	......	......	60	......
359	Sheldon	F. Knox's	.312	Marked	"	......	......	25	......
360	Sheldon to Houston	P. Peterson's	.650	"	S. trace	......	......	308	......
361	"	T. Thompson's	.312	Distinct	Absent	.28	......	306	49
362	"	John Ludvig's	.312	"	"	......	10.0	320	......
363	"	Badger Springs	.312	Marked	"	.12	8.0	......	......
364	"	H. Olson's	.208	Absent	"	......	......	35	......
365	"	Saunder's	.208	"	"	.14	8.0	140	32
366	LaCrosse, Wis	LaCrosse, city supply	.936	"	"	......	8.0	500	38.4
367	"	Heilmann's brewery	.936	"	"	......	8.0	500†	......
368	Rushford r'd.	Louis Knudson's	.208	"	"	.92	......	118	......
369	"	Ludvig Bjerke's	.312	Marked	"	......	7.0	136	......
370	"	Peter Miller's	.312	Absent	"	......	......	215	32
371	"	Gunder Ness'	.312	Marked	"	.24	......	16	......
372	"	Jacob Pfeiffer's	.312	Trace	"	.28	......	88	......
373	"	Peter Hoyom's	.416	"	S. trace	......	......	315	......
374	"	C. Davis'	.832	Marked	"	.44	......	70	......
375	"	O. L. Clausen's	1.14	Absent	Absent	High	......	200	......
376	"	Reiar Benson's	.728	Strong	Trace	.24	......	65	......
377	"	John Swendson's	.416	Marked	S. trace	......	......	40	......
378	"	O. E. Grinde's	.208	Trace	"	......	7.0	75	......
379	"	W. Robertson's	1.24	Marked	"	.32	......	30	......
380	Winona	Winona city well	7.28	Absent	Absent	.14	8.0	Un.§	26
381	"	Winona, city dug	1.82	Strong	Trace	.42	8.0	50	22.4
382	"	Lake Winona	.312	Absent	Absent	......	......	......	......
383	"	Boegie's spring	.312	S. trace	"	......	......	......	......
384	"	C. P. Shepherd's	.312	Distinct	"	......	......	......	......
385	"	C. F. Buck's	.312	Absent	"	......	......	......	......
386	"	Winona, city tap	6.24	Marked	Marked	.40	......	......	......
387	"	Winona, city mixed	6.24	Strong	Trace	.34	......	......	......
388	"	Winona, city tap	6.24	"	Absent	......	......	......	......
389	"	Kosciusko school	5.12	"	Distinct	.34	......	......	......
390	"	Lincoln school	6.24	"	Marked	.60	......	......	......
391	"	Mr. Morrison's	6.24	"	"	.34	......	......	......
392	"	Mississippi river	.760	Absent	Absent	1.08	4.0	......	18
393	Winona to Minn. Cy	Laird, Norton & Co	15.6	"	"	.10	10.0	460	30.8
394	"	Miller's artesian	8.58	"	"	.06	8.0	360	24
395	"	Fiefield's	.312	Marked	"	......	8.0	35	......
396	"	Roadside well	.624	Strong	"	......	6.0	......	......
397	"	Dumon's	1.64	"	Distinct	......	6.0	......	......
398	"	Turner's	.208	Marked	Absent	......	8.0	......	......
399	"	G. W. Dickens'	.208	Distinct	"	......	12.0	......	......
400	"	W. R. Stewart's	.614	Strong	"	......	8.0	80	......
401	Rollingstone.	Rollingstone creek	.312	Marked	Distinct	......	......	......	......
402	"	Rollingstone town well	.312	Absent	Absent	......	......	238	......
403	"	Rollingstone tap	.416	"	"	......	......	......	......
404	"	B. Kohner's	.312	Marked	"	......	......	196	......
405	"	Felix Spilt's	.312	"	"	......	......	84	......
406	Sugar Loaf	Phil Feitung's	.208	Absent	"	......	......	285	41.6
407	"	C. W. Anding's	.208	"	"	......	......	332	......
408	"	H. Bohn's	.416	"	"	......	......	317	......
409	"	W. P. Hammond's	.208	"	"	......	......	365	32
410	Lewiston	Lewiston village well	3.74	Strong	Distinct	.10	7.0	277	35
411	"	Lewiston reservoir	4.16	"	Absent	.14	......	......	......
412	"	Creameries	.312	Marked	"	.16	7.0	343	27.4
413	St. Charles	City well	1.14	Strong	S. trace	.12	6.0	942	34.4
414	"	St. Charles railroad spring	.416	Marked	"	.35	6.0	......	31.2
415	"	Weeks' spring	.208	Strong	Absent	......	......	......	......
416	"	Clyde postoffice spring	.208	Marked	S. trace	......	......	......	......
417	"	Nesbit, No. 1	.208	Distinct	Trace	......	......	247	......
418	"	Nesbit, No. 2	.208	"	Absent	......	......	301	......
419	"	J. Campbell's	.312	Marked	"	......	......	150	......
420	"	Schermerhorn's	.312	Trace	Absent	......	......	......	......
421	"	G. Garber's	.728	Strong	"	.41	7.0	35	29.6

† Plus.
§ Uncertain.

FIELD ANALYSES—*Continued.*

Number.	Location.	Where Taken.	Chlorine.	Nitrates.	Nitrites.	Consumed Oxygen.	Alkalinity.	Depth.	Hardness.
422	Dover	G. J. Bush's	2.08	Strong	S. trace	.28	4.0	90	38.4
423	"	D. Betri's	2.08	"	Trace	......	......	90	......
424	"	Abe Libby's	1.76	Marked	S. trace	......	......	90	......
425	"	Representative Bush's	2.49	Strong	Absent	......	......	90	......
426	"	L. W. Ingham's	5.09	Marked	S. trace	.71	3.0	90	42.8
427	Eyota	Eyota town pump	3.08	"	Marked	.11	6.0	140	46
428	"	Barney Fallum's	3.22	"	Distinct	.13	10.0	135	......
429	"	Schoolhouse	1.87		"	.13	8.0	118	......
430	"	John Coon's	.582	Strong	Absent	.11	8.0	184	......
431	"	Railroad well	.624	Marked	"	.33	6.0	140	42
432	Byron	Byron town well	.208	Distinct	"	.11	8.0	182	46
433	"	J. B. Hicks'	.208	Absent	S. trace	......	......	132	......
434	"	C. E. Sinclair's	.208	Trace	Absent	......	......	87	37.2
435	"	J. T. Jones'	10.40	Marked	S. trace	......	......	54	......
436	Kasson	Kasson city tap	3.74	"	"	.18	4.0	174	50.4
437	"	Kasson town pump	4.57	Distinct	Distinct	......	......	100	......
438	"	Railroad well, Kasson	1.24	Marked	Trace	......	......	140	39.2
439	Rochester	Rochester city supply	.676	Strong	"	.24	6.0	35	......
440	"	Zumbro river	.312	Distinct	Distinct	.30	6.0	......	......
441	Dodge Center	Dodge Center town well	.208	Absent	Absent	.15	6.0	165	32.8
442	"	Great Western R. R. well.	.208	S. trace	Distinct	.19	8.0	500	34.8
443	"	School, Dodge Center	10.6	V. strong	Marked	.44	8.0	60	60.8
444	Rochester	Bear creek	.208	Marked	Trace	.20	6.0	......	26
445	Reno	Wm. Kroack's	.312	Trace	"	......	......	107	......
446	"	Reno school spring	.208	Distinct	Absent	......	......	......	......
447	"	J. Layland's	.260	Trace	"	......	......	90	......
448	"	Dolands'	.312	Distinct	"	......	......	90	......
449	"	Layland's	.312	"	"	......	......	136	......
450	Caledonia	Springs near Caledonia	.312	Marked	"	......	......	......	......
451	"	Krueger creek	.312	Absent	"	......	......	......	......
452	"	Freeburg creek	.260	Trace	"	......	......	......	......
453	Freeburg	J. R. Graf's	1.2	Absent	"	.12	8.0	650	......
454	"	Links' spring	.312	Trace	"	......	......	......	......
455	"	G. Davy's	.260	Absent	"	......	......	302	......
456	"	Lampert's spring	.312	Marked	"	......	......	......	......
457	Brownsville	Madcap flowing well	.70	Trace	"	.15	8.0	600	38
458	"	T. Daly's	.312	Distinct	Trace	......	......	303	......
459	"	J. Fishel's	.312	Marked	"	......	......	270	......
460	"	Mike Giblits'	.312	S. trace	Absent	......	......	287	......
461	"	J. A. W. Daly's	.312	Distinct	"	......	......	280	......
462	Caledonia to S. Grove	Doyle's	.312	Absent	"	......	......	260	......
463	"	S. N. Wheaton's	.90	"	"	......	......	......	......
464	"	Chas. McCarthy's	.312	"	"	......	......	290	......
465	"	H. Johnson's	.312	"	"	......	......	291	......
466	"	A. Stone's	.80	Strong	"	......	......	360	......
467	Wilmington	T. Freehouse's	.60	Absent	"	......	......	350	......
468	Spring Grove	O. W. Jardenning's	.312	"	"	......	......	250	......
469	"	Spring Grove town wells	4.00	Strong	Trace	......	......	100-400	......
470	"	Spring Grove R. R. well	.416	Trace	Absent	......	......	127	......
471	"	Nels Hendrickson's	.60	....	"	......	......	400	......
472	S. Grove to Caledonia	Ole Storen's	.312	....	"	......	......	210	......
473	"	Gunder Jdorn's	.60	....	"	......	......	257	......
474	"	A. E. Carlsbroten's	.60	....	Trace	......	......	218	......
475	"	Ole Lee's	.312	Absent	Absent	......	......	235	......
476	"	Senator T. Johnston's	1.00	"	"	......	......	300	......
477	"	Aling Solon's	.416	"	"	......	......	212	......
478	"	A. P. Pranet's	.60	Strong	"	......	......	180	......
479	"	F. Korpstein's	.312	Absent	"	......	......	273	......
480	"	P. Mullepere's	.312	"	"	......	......	264	......
481	LaCrescent	Levi Atkinson's	.312	S. trace	"	......	......	200	......
482	Hokah	Convent	.312	Absent	"	......	......	300	......
483	"	C. Dahke's	.312	S. trace	"	......	......	300	......
484	"	J. Kline's	.312	"	"	......	......	262	......
485	"	P. Pilger's	.312	"	"	......	......	223	......
486	Winona to Wytoka	C. W. Merritt's	.60	Strong	Strong	......	......	332	......
487	"	Pat Monahan's	.50	Marked	Absent	......	......	281	......
488	"	Merritt's spring	.260	S. trace	"	......	......	......	......
489	"	John Monahan's	.312	Marked	"	......	......	272	......
490	"	Wm. Koehler's	.416	"	"	......	......	265	......
491	"	J. R. Brown's	.208	Trace	Marked	......	......	248	......
492	Ridgeway	A. D. Sinclair's	.312	Marked	Absent	......	......	276	......

† Plus.

FIELD ANALYSES—*Continued.*

Number.	Location.	Where Taken.	Chlorine.	Nitrates.	Nitrites.	Consumed Oxygen.	Alkalinity.	Depth.	Hardness.
493	Ridgeway....	J. Morrison's..............	.260	Marked	Absent	......	......	218	......
494	Wiscoy	Luke Nagel's	.208	"	"	......	......	208	......
495	"	Small creek, near Wiscoy.	.312	"	"	......	......	......	......
496	"	Wiscoy creek..............	.312	"	"	......	......	......	......
497	"	T. Lynch's.................	.312	Distinct	"	......	......	85	......
498	Wilson.......	Peter Oech's.............	.312	"	"	......	......	200	......
499	Winona	Creek near Winona........	.312	"	"	......	......	......	......
500	"	Getzman's	.312	Absent	"	......	......	221	......
501	LaCrosse to LaMoille	Spring near Richmond....	.312	"	"	......	......	......	......
502	"	Creek near Richmond.....	.208	Distinct	"	......	......	......	......
503	"	Barber's spring...........	.312	S. trace	"	......	......	......	......
504	Wabasha.....	John Carrell's, 1½ miles S.	1.1	Distinct	"	......	......	65	......
505	"	John Basse's, 3 miles S	.9	Marked	"	.24	......	262	......
506	"	Aug. Eber's, 5 miles S. W..	1.7	Trace	"	......	......	35	......
507	"	Joe Basse's, 3 miles W.....	.4	Absent	"	......	......	277	......
508	"	Hurd House well, No. 1....	.3	"	"	.36	......	28	......
509	"	Hurd House well, No. 2....	1.25	Strong	"	.14	......	......	......
510	"	Dr. H. O. Kelly's...........	.9	Marked	"	......	......	40	......
511	"	Mr. Bleyley's	2.0	....	"	......	......	30	......
512	"	Jail well, No. 1............	2.7	....	"	......	......	60	......
513	"	Jail well, No. 2............	2.3	....	Strong	......	......	50	......
514	"	Courthouse	1.3	....	Absent	......	......	60	......
515	Lake City....	H. A. Young's.............	2.3	Strong	"	.23	......	45	......
516	"	Sloben's....................	2.4	....	"	......	......	45	......
517	"	Postoffice well............	2.2	Strong	Trace	......	......	......	......
518	"	Dr. Fitzgerald's...........	0.7	....	Absent	......	......	40	......
519	"	Camp spring...............	0.4	Absent	Trace	.13	......	......	......
520	"	Lake City flour mill.......	1.5	Strong	Absent	......	......	16	......
521	"	City well..................	1.1	Trace	Trace	.22	......	......	......
522	"	Wm. Evan's, 1 mile N.....	.7	....	Present	......	......	40	......
523	"	Longcoe's..................	.5	....	Absent	......	......	20	......
524	"	Nordeen's, on Gardner r'd	.35	Strong	"	......	......	......	......
525	"	Jewell Nursery, 1½ mi. W.	.35	Trace	"	.16	......	80	......
526	"	Dilley's, 1¾ miles W.......	.3	Strong	"	......	......	125	......
527	"	Gardner spring, 2½ mi. W.	.35	Trace	"	.12	......	......	......
528	"	Spring Farm spring.......	.25	"	"	......	......	......	......
529	"	Brook Lodge spring.......	.25	....	"	.18	......	......	......
530	"	Schoolhouse, 5½ miles W..	.25	....	"	......	......	......	......
531	"	H. Burfiend's, 9 miles W...	.4	Marked	Trace	......	......	249	......
532	"	Bill Murray's, 8 miles.....	.25	Trace	Absent	......	......	230	......
533	"	Stevens', 6 miles S. W.....	.4	Marked	"	......	......	269	......
534	"	Bryan's spring, 4 miles S..	.25	Trace	"	.14	......	......	......
535	"	Miller's spring, 2 miles S..	.25	Marked	"	......	......	......	......
536	"	Railroad well at depot....	.63	"	"	......	......	75	......
537	"	Railroad flowing well......	140.0	See Lab.	Analysis	No.	486.	820	......
538	"	Mississippi river at Pepin..	.30	Absent	Absent	.94	......	75	......
539	"	Mississippi river nr. sewer	.55	"	"	.98	......	......	......
540	"	Mississippi river nr. hotel.	.45	"	"	.97	......	......	......
541	"	Beckman's ice field in Miss.	.50	"	"	.93	......	......	......
542	Stockton, Wis	Anderson's................	.25	"	"	.22	......	378	......
543	Plainview....	Town well..................	.285	Trace	"	.36	18.0	692	......
544	"	Schultz's city well.........	.38	S. trace	"	.30	20.0	285	......
545	"	G. R. Hall's	9.5	Strong	Marked	.61	26.0	30	......
546	"	Schultz's, 2 miles E........	.285	S. trace	S. trace	.30	20.0	......	......
547	"	Murray's, 2½ miles E......	.285	Marked	Absent	......	18.0	303	......
548	"	Spring, 6 miles E..........	.285	"	"	......	18.0	......	......
549	"	Spring, 7½ miles E.........	.285	Trace	"	.58	20.0	......	......
550	Beaver.......	A. A. Miller's...............	2.66	Strong	Marked	.53	10.0	12	......
551	Elba..........	Town pump................	.285	Trace	S. trace	.22	20.0	29	......
552	"	White Water river.........	.19	S. trace	Absent	.33	18.0	......	......
553	Elgin.........	Town supply..............	1.04	Strong	"	.19	16.0	152	......
554	"	Town tap	1.04	"	"	.168	15.0	......	......
555	"	Z. Williams'...............	1.52	"	"	.168	18.0	85	......
556	"	Schultz's...................	3.61	"	"	......	24.0	50	......
557	Plainview....	John Mathews', 2 miles W.	.19	Absent	"	.168	21,0	290	......
558	Potsdam	Town pump................	.19	Trace	"	.28	19.0	200	......
559	"	Hoffman's, 2½ miles N.W.	.285	Marked	"	.22	19.0	274	......
560	Hammond....	M. J. Muldoon's..........	.475	"	"	.22	22.0	20	......
561	"	Zumbro river..............	.285	Absent	Trace	.50	18.0	......	......
562	Milville	McGuiggan's	.76	Trace	Strong	2.46	5.0	90	......
563	"	Creamery well............	.66	Marked	Trace	.25	21.0	82	......

† Plus.

FIELD ANALYSES—*Continued.*

Number.	Location.	Where Taken.	Chlorine.	Nitrates.	Nitrites.	Consumed Oxygen.	Alkalinity.	Depth.	Hardness.
564	Plainview	M. A. Grove's, 9 miles N.W.	.285	Trace	Absent	.22	22.0	300	......
565	"	F. Meachum's, 3 miles E.	.19	S. trace	"	......	22.0	297	......
566	"	Wedge's	.285	Marked	Marked	.19	20.0	300	......
567	"	Carroll's	.285	"	Absent	.19	18.0	300	......
568	"	Town tap	.285	Trace	"	.14	18.0	......	......
569	Owatonna	Town surface well	.855	Strong	S. trace	.36	29.0	......	......
570	"	Deep town well	.285	Absent	Absent	.28	30.0	80	......
571	"	Mixed supply	.712	Strong	S. trace	.30	29.0	20–474	......
572	"	Owatonna House	.617	Marked	"	.42	29.0	......	......
573	"	Straight river	.142	Absent	Absent	1.37	25.0	......	......
574	"	State School, No. 1	.142	"	"	.39	......	160	......
575	"	State School, No. 2	.142	Trace	"	.44	24.0	160	......
576	"	Mineral springs	.142	Absent	"	.36	22.0	......	......
577	"	Frank Fisher's, 3 m. N. E.	.19	Marked	"	......	......	20	......
578	"	Frank Fisher's, No. 2	.142	Absent	"	......	20.0	91	......
579	"	Railroad well	2.28	Strong	"	......	......	30	......
580	"	Roadside well, 1 mile W.	.665	Markad	"	......	......	......	......
581	"	Morford's, 2½ miles W.	1.42	Strong	"	......	......	52	......
582	"	Jenke's, 3½ miles W	.142	S. trace	"	.33	30.0	30	......
583	"	Stockwell's	.284	Marked	S. trace	.36	......	135	......
584	"	Fred Settee's	.142	S. trace	"	......	28.0	109	......
585	"	C. W. Vinton's, 10 miles S.	.142	Absent	Absent	.36	29.0	93	......
586	River Point	Creamery, flowing	.142	S. trace	"	.44	29.0	96	......
587	"	Henry Boechert's flowing.	.142	"	"	......	24.0	110	......
588	"	Girousek's flowng	.142	"	"	.42	......	100	......
589	"	Busho's, 1 mile S.	.142	"	"	.36	30.0	100	......
590	"	M. Chuster's, 9 miles S.	.142	"	"	......	29.0	102	......
591	"	Healy's, 6½ miles S.	.38	Absent	"	.67	29.0	202	......
592	"	Roadside, 3½ miles S.	.522	Marked	Trace	......	......	......	......
593	Blooming Pr.	Town well	.237	Absent	Absent	.42	23.0	165	......
594	"	Street well	11.87†	Strong	S. trace	......	......	20	......
595	"	Creamery well	.190	Absent	Absent	.56	26.0	150	......
596	"	Two railroad wells	4.29	Strong	Trace	......	......	......	......
597	"	Commercial House	41.	V. strong	Strong	......	......	20	......
598	Dodge Center	M. A. Race's	.475	S. trace	Trace	.30	23.0	107	......
599	"	Anderson's spring	.190	Absent	Absent	.30	20.0	......	......
600	"	Zumbro river, 1 mile N.	.37	"	"	......	......	......	......
601	"	Spring on river	.665	Marked	"	.36	19.0	......	......
602	"	Geo. Norton's, 5 miles N.	.190	Absent	"	.33	26.0	50	......
603	"	Hitchcock's, 5 miles N.	.142	"	"	.30	25.0	......	......
604	Mantorville	F. E. Joslyn's	1.52	Marked	Trace	......	......	122	......
605	"	Brewery spring	.285	Trace	Absent	.22	20.0	......	......
606	Dodge Center	Shulte's	1.61	Strong	"	......	......	20	......
607	Waseca	Town well	.142	S. trace	"	.47	34.0	118	......
608	"	Town tap	.142	Trace	Marked	.44	......	......	......
609	"	H. W. Smith's, 15 mi. S.W.	.190	Absent	Absent	.50	......	......	......
610	"	Wm. McGonagle's, 15 miles	.285	"	"	.56	41.0	......	......
611	"	McDonough's, 15 mi. S. W.	.237	"	"	.56	34.0	......	......
612	"	McArdle's	.332	S. trace	"	.53	35.0	91	......
613	"	Aug. Hohensee's	.332	"	"	......	33.0	......	......
614	N. Richland	Town pump	.285	Absent	"	.44	34.0	114	......
615	"	W. Iver's	.095	S. trace	"	.72	31.0	96	......
616	Waseca	Clear Lake ice	1.37	Absent	"	2.54	10.0	......	......
617	Waterville	Village supply	.142	"	Trace	.56	30.0	175	......
618	"	Flour mill	.142	S. trace	Strong	.44	30.0	65	......
619	"	Creamery	.142	"	Absent	......	31.0	85	......
620	Elysian	Town well	.142	Trace	Trace	.49	......	287	......
621	"	Town tap	.142	"	Absent	.61	26.0	......	......
622	"	Lake Francis	.142	Absent	"	1.07	......	......	......
623	"	Flour mill	.142	"	"	.92	28.0	144	......
624	"	Geo. Bruce, 2½ miles S.W.	.332	"	"	......	......	167	......
625	"	Roadside, 3½ miles S. W.	.237	"	"	......	......	84	......
626	Janesville	Town well	1.71	"	Trace	......	......	84	......
627	"	Dr. Taylor's	.380	Trace	Absent	......	......	60	......
628	"	Fellow's, 4½ miles W.	.142	"	"	.43	......	......	......
629	Mankato	Mineral springs, 9½ mi. E.	.142	"	"	.51	......	140	......
630	Eagle Lake	Town well	.142	"	Trace	.71	......	112	......
631	Madison Lake	Village well	.142	Absent	Absent	......	......	......	......
632	"	Madison Lake	.142	"	"	1.66	......	180	......
633	Elysian	John Pine's, 4 miles W	.190	"	"	......	......	......	......
634	"	Lake Elysian	.142	Distinct	"	4.46	......	265	......

† Plus.

FIELD ANALYSES—*Continued.*

Number.	Location.	Where Taken.	Chlorine.	Nitrates.	Nitrites.	Consumed Oxygen.	Alkalinity.	Depth.	Hardness.
635	Mapleton.....	Town supply...............	.52	Trace	Absent	.73	......	.....	......
636	"	Town tap..................	.52	Marked	Trace	......	......	......	......
637	"	Geo. Plymets'..............	.475	Absent	Absent	.49	......	......	......
638	"	Knight's artificial lake....	1.9	"	"	1.92	......	......	......
639	"	J. W. Sprague's 3 miles S.	.426	"	"	......	......	......	......
640	"	Hussey's, 3 miles S........	.475	"	"	......	......	......	......
641	"	Maple river, 3 miles S......	.855	"	"	4.02	......	......	24.8
642	"	Hartke's, ½ mile E........	.380	"	"	......	......	......	......
643	"	Hanke's, ¾ m. from Hartke	.380	"	"	......	......	100	......
644	"	O. C. Healy's, 7½ miles S..	.380	"	"	......	......	......	......
645	"	D. McGregor's, No. 1......	.380	"	"	......	......	45	......
646	"	D. McGregor's, No. 2......	.380	"	"	......	......	......	......
647	"	E. Healy's, 6½ miles S.....	.380	"	"	......	......	40	......
648	"	Jno. McGregor's, 6 miles S.	.475	"	"	......	......	......	......
649	"	Jno. McGregor's, No. 2....	.52	"	"	......	......	......	......
650	"	G. A. Farnsworth's, 5½m.	.380	"	"	......	......	50	......
651	"	C. E. Whitney's...........	.284	"	"	......	......	35	......
652	"	S. T. Whitney's, 6 miles S.	.284	"	"	......	......	140	......
653	"	Ben Taylor's, 4½ miles W.	.426	"	"	......	......	......	......
654	"	Jud. Cornell's, 4 miles W..	.380	"	"	......	......	30	52
655	"	Jud. Cornell's, No. 2.......	.380	"	"	.55	......	32	49.6
656	"	G. Hollenback, 4 miles W.	.426	"	"	.40	......	32	49.2
657	Sterling Ce'tr	Street well................	.284	"	"	......	......	30	......
658	"	C. C. Troy's...............	.142	"	"	......	......	65	......
659	Amboy.......	Town well.................	.765	Marked	Marked	.49	......	485	55.6
660	"	Town tap..................	1.42	Strong	Strong	......	......	......	......
661	Lake Crystal.	Hotel well.................	12.82†	....	....	......	......	......	......
662	"	Park well..................	3.32	Strong	Absent	......	......	......	......
663	"	Crystal lake...............	.475	Absent	"	......	7.0	......	......
664	"	Street well................	1.99	Strong	"	......	......	30	......
665	"	Mill well*.................	.475	Absent	Trace	9.64	360.	780	......
666	St. James....	Springs, 1½ miles N. E....	.37	"	Absent	.81	......	......	......
667	"	Creek above sewer........	12.5	Marked	Marked	......	......	......	......
668	"	Creek below sewer........	17.5	Strong	Strong	......	......	......	......
669	"	Dr. Rowe's................	1.6	Marked	Absent	.49	......	25	......
670	"	St. James lake............	.665	Absent	"	......	65.0	......	......
671	"	Dr. Lewis's...............	61.75	Strong	Marked	......	......	......	......
672	"	High school...............	.190	Trace	Absent	.28	......	......	......
673	"	Gibb's Hotel..............	20.00	Marked	Trace	......	......	31	......
674	"	Town well.................	.95	Absent	Absent	.48	80.0	501	......
675	Windom.....	Town supply...............	.475	Trace	S. trace	......	......	18	......
676	"	Town tap..................	.475	"	Absent	......	......	......	......
677	"	Des Moines river..........	.380	Distinct	S. trace	3.52	14.0	......	30
678	"	Park well.................	1.42†	Marked	Absent	......	......	......	......
679	"	Fish lake, 4 miles S. E.....	.095	Absent	Absent	2.32	11.0	......	17.2
680	Bingham Lk.	Railroad well..............	2.08	Strong	Strong	......	......	320	......
681	Mountain Lk.	Town well.................	.522	"	Trace	2.26	22.0	41	53.3
682	"	J. D. Schreider's...........	1.23	"	"	......	28.0	33	......
683	"	Dr. Friesen's............ ..	2.85†	"	Strong	......	......	13	63.6
684	Windom.....	Bastin's, 16 miles N........	.142	Absent	Absent	.55	31.0	25	......
685	Heron Lake..	Town pump.................	.380	S. trace	"	.26	33.0	178	......
686	"	Public tap.................	.475	Trace	"	......	......	......	......
687	"	Dr. Hansen's..............	5.7†	Strong	Trace	.17	......	30	......
688	"	Trimble's..................	3.8†	"	Absent	......	......	30	......
689	"	Railroad well..............	.380	Absent	"	.19	30.0	204	......
690	"	Ice from Heron lake.......	.142	"	"	.19	......	......	......
691	"	Spring, 3 miles............	2.75	....	Strong	......	......	......	......
692	Slayton......	Old town well.............	.475	S. trace	Trace	.26	30.0	208	120
693	"	Town tap..................	.522	"	"	......	......	......	......
694	"	Murray county poor farm	.380	"	S. trace	......	31.0	206	......
695	"	O. A. Lunder's, 3 miles S..	.285	Absent	"	.15	25.0	110	61.6
696	"	Murdock's, 3 miles south..	.285	"	Absent	.13	24.0	180	62.8
697	"	J. Anderson's, 5½ miles...	.332	"	"	......	25.0	100	......
698	"	A. Abrahamson's, 4 mil. S.	.237	"	"	.11	24.0	100	63.6
699	"	C. E. Dinehart's...........	.380	S. trace	"	.13	32.0	186	104
700	"	Priem's, 1½ miles W.......	.285	Marked	Trace	.24	27.0	500	61.2
701	"	Frank Gass', 2½ miles W..	.190	S. trace	Absent	.19	32.0	......	82
702	Hadley.......	J. Sandy's, 1 mile W.......	.237	Absent	"	......	26.0	50	......
703	"	K. A. Simonson's, 1 mi. W.	.190	S. trace	"	......	28.0	......	......
704	Slayton......	Fred Mann's, 8 miles N.W.	.190	Absent	"	......	......	......	......
705	"	J. Erickson's, 3 miles S....	.427	"	Marked	......	28.0	157	......

*Not a fair sample.

† Plus.

FIELD ANALYSES—*Continued.*

Number.	Location.	Where Taken.	Chlorine.	Nitrates.	Nitrites.	Consumed Oxygen.	Alkalinity.	Depth.	Hardness.
706	Slayton	J. Nelson's, 7 miles S. E....	.332	Absent	Absent	......	24.0	100	69.2
707	"	Ice from creek..............	.142	"	"	......	2.0	......	26
708	Pipestone.....	Town well................	3.6	Strong	"	......	22.0	340	......
709	"	Town well, No. 2..........	3.7	Marked	"	......	22.0	196	......
710	"	Town tap at hotel.........	4.03	"	"	.23	22.0	......	64
711	"	Meyer's, 8 miles S. E.......	.475	S. trace	"	.23	25.0	537	......
712	"	Cody's, 3 miles S. W.......	.237	"	"	.23	26.0	......	......
713	"	W. S. School..............	.285	Marked	"	.29	24.0	14	......
714	"	Spring, 1¼ miles N........	.237	"	"	.91	5.0	......	......
715	"	New town well...........	1.33	Absent	"	......	13.0	18	......
716	"	Town pump................	7.31	V. strong	"	.29	24.0	35	......
717	"	Ice from two lakes	.142	Trace	"	.32	1.0	......	......
718	"	Omaha railroad...........	.570	....	"	......	......	365	......
719	"	J. B. Flag's, 2½ miles N...	.380	....	"	......	......	265	......
720	"	Roller mill................	.332	Absent	"	......	......	250	......
721	"	C. Ridgeway's.	.332	"	"	......	......	141	......
722	"	A. B. Curl's, 1½ miles S. E.	.380	"	"	......	......	180	......
723	"	Great Northern R. R.	.237	Marked	"	.29	......	20	......
724	"	R. S. Goodell's............	7.6	"	S. trace	......	......	22	......
725	Lake Benton.	Roadside spring, 1 mile S.	.190	Absent	Absent	......	......	......	......
726	"	Town well.................	1.3	S. trace	"	......	......	14	......
727	"	Spring, ¾ mile N. E........	.190	Absent	"	1.08	......	......	52
728	"	Ice from Lake Benton.....	1.04	Trace	"	.48	......	......	......
729	"	Tremont Hotel	4.7	Strong	Trace	......	......	70	......
730	Tracy	Town well................	1.52	Absent	"	.13	......	680	57.4
731	"	Hotel tap.................	1.82	Distinct	Absent	......	20.0	......	......
732	"	Lake Seigel, 2 miles S	.142	....	"	......	8.0	......	......
733	"	Rice's spring, 7½ mi. S. W.	.095	S. trace	"	.54	37.0	......	......
734	"	Lake Shetek, 10 miles S. W.	.095	Absent	"	......	9.0	......	......
735	Owanka......	Hotel Wakeaska...........	6.65	"	"	.63	31.0	42	216
736	"	Tepeeotah Ass'n...........	.66	Marked†	"	.45	22.0	40	......
737	Tracy	Quarlon's, 2 miles N. E....	.52	Absent	"	.51	28.0	60	......
738	"	W. P. Elliot's, 6 mls. N. W.	.190	"	"	.45	32.0	60	......
739	"	H. Buck's, 8 miles N. W.	.42	"	"	......	29.0	130	......
740	"	Roadside well.............	.66	Marked	S. trace	......	......	......	......
741	Marshall.....	Town well................	3.23	Absent	Absent	.51	30.0	396	104
742	"	New town well...........	15.5	"	S. trace	.30	15.0	248	......
743	"	Redwood river............	2.3	Strong	Strong	......	......	......	......
744	"	F. B. Wheeler's...........	16.1	Absent	S. trace	.36	16.0	250	......
745	"	Street pump..............	6.17	Marked	"	.48	34.0	14	......
746	"	J. Shute's, 2½ miles E.....	5.22	Absent	Absent	......	27.0	300	......
747	"	Sutherland's	10.92	"	Trace	......	22.0	225	......
748	"	W. A. Fuller's, 4 miles S. E.	4.75	S. trace	Absent	.24	30.0	400	......
749	"	G. D. Forbes', 1½ miles S..	3.32	Absent	"	.21	28.0	435	......
750	"	A. T. Maxson's, ¼ mile S..	13.77	"	"	......	19.0	268	......
751	"	Marshall Milling Co's.	3.8	"	"	.24	30.0	406	......
752	"	Wm. Geiseke's............	4.03	"	S. trace	.21	29.0	400	......
753	"	Chris. Peters', 3½ miles W.	3.8	V. strong	Strong	......	31.0	55	......
754	"	C. Huisenfeldt's, 5½ m. W.	1.42	Absent	Absent	.27	25.0	225	......
755	"	Huisenfeldt's spring.......	.380	"	Trace	......	29.0	......	......
756	"	Offerdt's, 7½ miles S. W...	.142	"	Absent	......	32.0	......	......
757	"	M. Burr's spring, 8 m. S. W.	.142	S. trace	"	......	......	......	......
758	"	J. Williams', 8 miles S. W..	.142	Trace	"	......	25.0	......	......
759	"	Steam laundry............	16.15	Absent	Trace	.30	......	248	......
760	"	Langland's store*.........	6.65	Marked	"	.48	......	248	......
761	"	Hardin & Burchard's......	13.7	Absent	S. trace	.33	......	248	......
762	"	Creamery well............	16.15	"	Trace	......	......	280	......
763	"	Lankey's, 6 miles N.......	2.13	S. trace	....	......	......	......	......
764	"	E. Dandurand's, 8 miles N.	52.25	Absent	Marked	......	......	150	......
765	"	R. LeBean's, 8½ miles N...	48.45	Marked	"	......	......	140	......
766	"	Wm. Taylor's, 7 miles N..	43.23	Trace	Trace	......	......	147	......
767	"	A. Coderre's..............	41.33	Marked	"	......	......	......	......
768	"	M. Vien's, 14 miles N......	9.97	Absent	Absent	......	......	178	......
769	"	I. L. Kolhei's, 15 miles N. E.	.95	"	Marked	......	......	90	......
770	"	T. K. Reishus', 15¼ m. N. E.	14.25	Marked	S. trace	......	......	175	......
771	Cottonwood..	Town well................	77.9	Absent	Marked	......	......	280	......
772	"	Flour mill	28.5	....	"	......	......	192	......
773	"	Farmers Elev. Co..........	.37	Strong	"	......	......	40	......
774	"	C. E. Patterson's..........	16.15	....	Trace	......	......	250	......
775	"	Hotel Atlantic............	77.9	V. strong	"	......	......	......	......
776	Mankato.....	R. Williams', 5 miles S. W.	27.55	Absent	Absent	.58	24.0	1,000	......

† Plus.
* Tank Sample.

FIELD ANALYSES—*Continued.*

Number.	Location.	Where Taken.	Chlorine.	Nitrates.	Nitrites.	Consumed Oxygen.	Alkalinity.	Depth.	Hardness.
777	Mankato......	Blue Earth river, 7 miles S.	.190	Absent	Absent	.91	16.0	......	......
778	"	Spring, No. 1, 7 miles S....	.57	"	"	.40	27.0	......	......
779	"	Spring, No. 2..............	.57	"	"	......	......	......	......
780	"	Spring, No. 3..............	.57	....	S. trace	......	......	......	......
781	"	Hubbard Milling Co.......	.57	Absent	Trace	......	......	660	......
782	"	Town supply...............	.57	"	Absent	......	......	660	......
783	"	Mankato Knitting Mills...	.57	"	"	......	......	590	......
784	"	Minnesota river	.380	"	S. trace	1.3	18.0	......	......
785	Belle Plaine..	Town tank	1.28	"	Trace	.31	......	......	......
786	"	Town well.................	1.28	"	Absent	.14	......	160	......
787	"	Railroad well.............	65.0	"	Trace	.21	......	106	......
788	"	Railroad well, No. 2.......	55.0	"	Absent	.14	......	66	......
789	"	Salt springs..............	0.37	"	"	.11	......	......	......
790	Madelia.......	Town supply...............	0.14	Trace	Trace	.15	......	212	......
791	"	Noonan Hotel tap..........	.142	....	Absent	.37	......	......	......
792	"	Springs nr. Watowan river	.142	Absent	"	.25	......	......	......
793	"	Watowan river............	.142	"	"	......	......	......	......
794	"	Bill's......................	3.7	Strong	"	.22	......	80	......
795	"	Lake Feldji ice	.142	Absent	S. trace	2.0	......	......	......
796	Montevideo..	Town supply...............	9.5	Trace	Trace	......	40.0	30	......
797	"	Creamery	5.2	Distinct	"	.465	......	20	......
798	"	Keithley's	.142	Marked	Marked	......	......	40	......
799	"	Carleton Lake	.35	Absent	Absent	......	......	......	......
800	"	Knute Leaben's	1.20	Strong	Marked	......	......	......	......
801	"	Ole Hansen's spring.......	.55	"	Absent	......	......	......	......
802	"	Minn. river, 3½ miles S. E.	.45	Trace	Trace	......	......	......	......
803	"	H. P. Nelson's, 5 miles S. E.	.142	Absent	"	......	......	......	......
804	"	Black Oak Lake, 5 m. N. E.	2.2	"	Absent	......	......	......	......
805	"	J. W. Turner's............	5.4	Marked	Strong	......	......	27	......
806	"	Schoolhouse...............	1.2	Absent	Absent	......	......	37	......
807	"	F. Shumway's spring......	.142	....	S. trace	......	......	......	......
808	"	Anderson's spring.........	.142	....	Trace	......	......	......	......
809	"	Haldeman's................	....	....	....	......	......	30	......
810	"	Murphy's	.70	....	....	......	......	110	......
811	"	Chippewa river............	.190	Trace	Trace	......	......	......	......
812	"	Institute well.............	.50	Absent	Absent	......	......	......	......
813	Canby	Town well.................	.475	"	"	.22	......	70	......
814	"	Town tap	.475	....	"	.24	......	......	......
815	"	Mayor Lund's..............	.237	Trace	"	.23	......	50	......
816	"	Scott's.....................	3.8	Marked	Trace	......	......	......	......
817	"	Canby creek dam..........	1.08	Strong	Strong	......	......	......	......
818	"	Creamery well.............	1.38	Marked	Marked	......	......	12	......
819	"	Dam near creamery.......	.95	Strong	Strong	2.7	......	......	......
820	"	Anderson's	.37	Absent	Absent	......	......	76	......
821	"	Creek above livery........	.237	S. trace	S. trace	......	......	......	......
822	"	Anderson's, No. 2.........	.28	Absent	Absent	......	......	76	......
823	"	A. Olesen's................	.37	"	"	......	......	40	......
824	"	Spring in pasture..........	.19	"	S. trace	......	......	......	......
825	"	C. Teban's, 5½ miles S.....	.28	S. trace	Distinct	......	......	85	......
826	"	Spring, 6½ miles S.........	.28	Absent	Absent	......	......	......	......
827	"	Spring, 8½ miles S.........	.332	S. trace	"	......	......	......	......
828	"	Spring, 3 feet from 827	.37	Distinct	S. trace	......	......	......	......
829	"	Two springs, 2½ miles S ..	.33	Absent	Absent	......	......	......	......
830	"	Spring, 1,000 feet from 829.	.19	"	"	......	......	......	......
831	"	Street well................	2.8	Strong	"	......	......	22	......
832	"	Well near LeSueur House	4.9	"	Distinct	......	......	20	......
833	"	Spring near livery stable..	.57	S. trace	Absent	......	......	......	......
834	"	Nelson's...................	.57	Trace	"	......	......	16	......
835	"	C. E. Carpenter's..........	.37	S. trace	Distinct	......	......	85	......
836	"	Klutzney's, 1½ miles N....	.332	Absent	Absent	....	......	120	......
837	"	Lac qui Parle river, 4 m. E.	.57	Marked	Trace	......	......	......	......
838	"	Arthur Hewitt's...........	.95	Trace	Distinct	......	......	66	......
839	"	P. Hantges', 10 miles E....	89.2	Absent	Trace	......	......	173	......
840	"	N. Slummer's	12.8	S. trace	Marked	......	......	205	......
841	"	G. Kienitz's, 13 miles E....	.6	"	S. trace	......	......	30	......
842	"	A. Kockleman's, 14 miles E.	2.4	Strong	Marked	......	......	70	......
843	"	B. Kockleman's, 1 mile N..	.28	S. trace	Absent	......	......	......	......
844	"	C. A. Carlyle's, 15 mi. S. E.	66.2	Marked	Strong	......	......	310	......
845	"	J. Orville's, 24 miles E.	81.5	"	Marked	......	......	175	......
846	"	W. Cole's, 5 miles E	.37	Absent	Trace	......	......	45	......
847	Marshall......	Lake Marshall.............	.142	"	Absent	3.33	......	......	......

† Plus.

FIELD ANALYSES—*Continued.*

Number.	Location.	Where Taken	Chlorine.	Nitrates.	Nitrites.	Consumed Oxygen.	Alkalinity.	Depth.	Hardness.
848	Granite Falls	Hotel Du Norde	26.6	Strong	S. trace	......	......	......	......
849	"	Dr. Cressy's	4.3	Marked	Trace	......	......	73	......
850	"	Public school	5.7	Strong	Strong	......	......	......	......
851	"	Public street well	.95	Marked	Distinct	......	......	50	......
852	"	Judge Powers'	17.1	Strong	Strong	......	......	14½	......
853	"	Judge Winter's	2.85	Marked	"	......	......	......	......
854	"	Mayor Volstead's	6.46	Strong	Distinct	......	......	......	......
855	"	Town pump	3.04	"	Absent	......	......	......	......
856	"	Minnesota river	.695	Marked	Trace	......	......	......	......
857	"	Estenson's spr'g, 5 m. N. W	.142	Absent	Absent	.12	......	......	......
858	"	J. Mooney's, 5½ mls. N. W.	.190	"	"	......	......	......	......
859	"	Munsen's, 6 miles N. W.	.38	"	"	......	......	145	......
860	"	Jenvold's, 6 miles N. W.	.142	"	"	......	......	145	......
861	"	Peterson's, 2½ miles N.	.665	"	"	......	......	145	......
862	"	Ice from Minnesota river	.142	"	"	.16	......	......	......
863	"	W. P. Baker's, 1 mile S.	.19	"	"	......	......	......	......
864	Hanley Falls.	Yellow Medicine river	.475	....	"	......	......	......	......
865	"	Town well	20.4	Trace	Trace	.18	......	250	......
866	Wood Lake	Town well	4.1	"	Absent	.61	......	160	......
867	Echo	Town well	.66	"	S. trace	.30	......	55	......
868	"	Echo Milling Co.	.095	Absent	Absent	......	......	60	......
869	"	Lecy, 6 miles N.	.19	....	Marked	......	......	52	......
870	Granite Falls	Homme, 10 miles S. E.	1.1	Trace	Absent	.16	......	100	......
871	"	Langmat's spr'g, 8 m. S. E.	.237	....	"	......	......	......	......
872	Sacred Heart	Town pump	5.7	Strong	"	......	......	43	......
873	Granite Falls	Dr. Cressy's dug well	.475	Trace	Trace	......	......	35	......
874	Dawson	Town well	9.9	Strong	Absent	......	......	90	......
875	"	L. Rue's	13.7	"	Distinct	......	......	113	......
876	"	Dr. Nelson's	3.8	Marked	Trace	......	......	80	......
877	"	A. Thompson's	.475	Absent	Absent	......	......	90	......
878	"	A. Thompson's, 2 miles S.	1.2	Distinct	....	......	......	72	......
879	"	Jackson's, 4 miles S.	.38	Absent	....	......	......	102	......
880	"	E. Tronder's, 4½ mi. S. W.	.19	"	....	......	......	85	......
881	"	Olsen's, 4½ miles S.	.475	"	....	......	......	75	......
882	"	Moulten's, 9 miles S.	.285	"	....	......	......	80	......
883	"	Galow's, 10 miles S. E.	.76	"	Absent	......	......	129	......
884	"	M. A. Griffith's, 5½ mil. S.	.38	"	....	......	......	97	......
885	"	Troupe's	1.2	Marked	Absent	......	......	24	......
886	"	Erickson's	1.4	S. trace	"	......	......	24	......
887	"	Lac qui Parle river	.95	Marked	Marked	......	......	......	......
888	"	Stratte's, 4 miles E.	1.5	Absent	Trace	......	......	242	......
889	"	A. Holte's, 6 miles N. E.	1.04	"	"	......	......	235	......
890	"	H. Larsen's, 6 miles N. E.	.475	"	"	......	......	185	......
891	"	Iver Quall's, 5½ miles N.	6.6	....	Absent	......	......	240	......
892	"	Prof. Phillips'	1.2	....	"	......	......	45	......
893	"	L. Peterson's, 2½ mi. N.W.	.66	....	Trace	......	......	185	......
894	"	O. P. Bergland's, 4 m. N.W.	1.1	....	Absent	......	......	228	......
895	"	J. Slende's, 7 miles N. W.	49.4	Absent	S. trace	......	......	254	......
896	Madison	Chalmer's dug	19.9	Distinct	"	.58	......	48	......
897	"	Kittsinger's farm, 4 mi. N.	74.5	....	"	......	......	400	......
898	"	Scordahl, 5½ miles N. E.	3.3	....	....	......	......	100	......
899	"	Hanko's, 6 miles N. E.	5.7	....	....	......	......	180	......
900	"	High school	76.0	....	....	......	......	313	......
901	"	J. R. Swan's	1.4	....	....	......	......	113	......
902	"	L. M. Maland's	2.3	....	....	......	......	150	......
903	"	Larsen's	2.1	....	....	......	......	140	......
904	"	Kittsinger's town well	2.6	....	....	......	......	160	......
905	"	T. Halvorsen's	2.6	....	....	......	......	137	......
906	Marietta	Lac qui Parle river, 4 m. S.	.76	....	....	......	20.0	......	......
907	"	Wolff, 3 miles S.	2.8	Absent	S. trace	......	27.5	50	......
908	"	Salt Lake, 4 miles S. W.	184.3	"	Absent	......	15.0	......	......
909	"	Harnstad's, 5 miles S. W.	3.8	....	....	......	27.5	143	......
910	"	Heckard, 5½ miles S. W.	8.5	Trace	Absent	......	30.0	165	......
911	"	Buckland's, No. 1, 6 m. S.W.	4.2	....	....	......	32.5	170	......
912	"	O. H. Buckland, 6⅛ m. S.W.	3.8	....	....	......	27.0	158	......
913	"	J. M. Buckland, 6⅛ m. S.W.	3.8	S. trace	S. trace	......	32.5	165	......
914	"	Buckla'd, No. 3, 6½ m. S.W.	3.3	Distinct	Trace	......	30.0	180	......

† Plus.

FIELD ANALYSES—*Continued.*

Number.	Location.	Where Taken.	Chlorine.	Nitrates.	Nitrites.	Consumed Oxygen.	Alkalinity.	Depth.	Hardness.
915	Marietta......	McAllister's, 6 miles S	3.3	S. trace	Trace	......	30.0	145	......
916	"	J. Luder's, 3½ miles S.	12.8	"	Strong	......	30.0	90	......
917	"	Town pump, dug well.....	9.5	Strong	Absent	......	35.0	......	......
918	Bellingham ..	J. J. Willis', 1 mile S	.76	S. trace	Strong	......	......	140	......
919	Madison......	Court house...............	2.8	"	Absent	......	14.0	185	......
920	"	A. W. Aws's...............	19.4	Strong	Distinct	......	......	15	......
921	"	Town well.................	1.4	Absent	S. trace	......	......	125	......
922	"	Bank spring...............	31.3	V. strong	Marked	......	......	......	......
923	"	Merchants Hotel	47.5	"	Trace	......	......	65	......

† Plus.

LABORATORY ANALYSES.

Under the above caption we include all of the waters examined in the laboratory from Nov. 6, 1899, to Sept. 20, 1900, some 233 in number. They include samples sent in by local authorities and samples collected by ourselves. The latter should, of course, be the preferable method for collecting water, as it is difficult to obtain an adequate description of environment and soil and subsoil stratification from interested parties.

Often the statement, "No near contamination," is extremely misleading, and has, in some instances of subsequent personal inspection, been changed to "Large barn, 100 feet on the up slope," or, "Cesspool, 100 feet distant," etc.

In all cases of municipal water supplies the analysis should be preceded by personal inspection and by a series of analyses of similar waters in the neighborhood. Of course, in such parts of the state as the survey has covered, the extra samples may be dispensed with.

The percentage of condemned waters in this list will naturally be very high, as they were, in the majority of cases, previously suspected, by reason either of surrounding conditions, which suggested probable pollution, or of enteric fever among the users. As a rule, when suspicious conditions environ a water, those suspicions are borne out by the chemical analysis.

Very often samples have been sent to the laboratory in old jugs, improperly cleaned, and bearing the odors of alcohol, whisky, etc.; old corks have also been used in bottles containing samples. Either of those conditions is likely to modify the examination.

To prevent these unsatisfactory methods of collection, we now send out half-gallon glass bottles, in strong wooden cases, forwarded, express prepaid, to any local health officer, on demand. For these bottles the express companies have granted us "Empties" rates. The return charge is now paid by the interested parties. On each bottle is pasted the following label:

SAMPLE OF WATER.

From .... of .... Minn.

No. .... Date and hour of collection..............

DIRECTIONS.

(a) Do not touch the inside neck of this bottle, nor the stem of its stopper.

(b) Rinse the bottle three times with the water to be examined and *drain each time.*

(c) If from a *stream, lake or reservoir,* collect from its center by plunging the bottle, mouth downwards, some six inches below the surface. *Avoid any scum or sediment.*

(d) If from a *well,* pump out all water *standing in the pipe* before rinsing the bottle.

(e) If from a *tap,* let flow five minutes.

(f) If from a *spring,* take directly from its head.

(g) Rinse the stopper carefully and fit in tightly, being *careful to leave some air space* in the bottle.

(h) Cover the stopper with the clean cotton cloth, tie down securely and seal.

(i) Ship *immediately* by prepaid express to

Laboratory Minnesota State Board of Health,

(U. of Minn.) Minneapolis, Minn.

Accompanying each package is an addressed return tag and a new piece of cotton cloth and string. Likewise a history blank as follows:

MINNESOTA STATE BOARD OF HEALTH.

BLANK FOR HISTORY OF WATER SAMPLE.

Collected by .... of ...., Minn., ...19..
Season (wet or dry) ......SOURCE OF WATER..................

....

NOTICE.—Under "Source of Water" must be given the following:

For a Well, give the depth; state whether it is bored, driven or dug; give the kind of curbing and its condition.

For a Lake, give the depth, the superficial area in square miles; also whether it is clear or weed-grown, has a free outlet, or is restrained by a dam.

For a Stream, give its depth, its width and whether it is clear or weed-grown, dammed or free.

For a Spring, give the quantity of its flow and whether it is increasing or decreasing in volume.

..........feet thick of.....................
..........feet thick of.....................
..........feet thick of.....................

Geological data

..........feet thick of.....................
..........feet thick of.....................
..........feet thick of.....................

NOTICE.—Give as accurately as possible the kinds of soil and rock in successive layers and the thickness of each layer. Begin at the surface and go down to the bottom. Give, where possible, the dip of the stratified rock and the geological data of neighboring wells.

DISTANCE AND NATURE OF POSSIBLE CONTAMINATION....
....
....

NOTICE.—Under above head give the number of feet from the water to any cesspool, outhouse, barnyard or other possible pollution,

If a lake or stream, give the condition of its shores as to dumps; sewage, outhouses, etc., also any connection with other polluted waters.

SLOPE OF THE SURFACE GROUND AND DIP OF THE STRATIFIED ROCK..
....
....

Note particularly whether the water supply is higher or lower than the contamination.

SICKNESS IN PERSONS USING THE WATER...............
....

All samples of water must be collected in a special bottle which will be sent out by the laboratory on application. The directions on it for collection should be rigidly followed, else the analysis will be of diminished value.

Expressage must be prepaid.

The payment of return charges often means money out of pocket for the health officer, because when he suspects a private well, and wishes it examined, there is no one else to pay said charges, as usually neither the person himself nor the village council is at all interested. I would recommend the payment of charges both ways. Probably we can secure a "mineral water" rate from the companies for the return expressage.

At first a piece of sealing wax was sent with each package for the purpose of sealing the string over the cloth, but too often it was put directly on the cork. This introduced the undesirable probability that pieces of the brittle wax might chip off and fall into the water when the cork was taken out. We have therefore discontinued its use.

LABORATORY ANALYSES.

ANALYTICAL DATA IN PARTS PER 100,000.

Number.	Location.	Where Taken.	Depth.	Chlorine.	Nitrites.	Nitrates.	Consumed Oxygen.	Ammonia. Free.	Ammonia. Albuminoid.
476	Winona	City supply	Un.‖	7.28	Absent	Absent	.14	.026	.004
477	"	C. W. Anding's	352	.203	"	"	.22	.010	.010
478	Freeburg.....	J. R. Graf's	650	1.20	"	"	.12	.004	.002
479	Brownsville..	The "Madcap"	600	.7	"	"	.15	.003	.003
480	Lake City....	Railroad well	820	140.0	"	"	.47	.030	.000
481	"	Railroad well	50	.7	"	Mark'd	.13	.010	.008
482	"	Brook Dodge spring	......	.3	"	Trace	.12	.000	.004
483	"	Camp spring	......	.4	"	"	.13	.008	.010
484	Elgin	Village well	152	1.04	"	Strong	.19	.012	.004
485	Elba	Village well	29	.285	S. trace	Trace	.22	.002	.004
486	Plainview....	Village well	629	.285	Absent	"	.36	.010	.004
487	Owatonna....	State school (2)	160	.142	"	"	.44	.020	.006
488	"	Public supply	Mix.	.95	Trace	Mark'd	.42	.026	.008
489	Tracy	Lake Shetek	......	.095	Absent	S. trace	2.20	.025	.042
490	Marshall	Village supply	248	15.50	S. trace	Trace	.30	High	.007
491	"	Village, new well	396	3.50	"	"	.51	High	.006
492	Minneapolis..	Mr. Seymour's	115	.70	Absent	Strong	.15	.000	.006
493	Caledonia	Village supply	300	1.30	"	"	.16	.000	.002
494	Belle Plaine..	Tank water	......	1.28	Trace	Absent	.312	.030	.010
495	"	Village well	160	1.28	Absent	"	.142	.006	.002
496	"	Railroad well	106	65.00	"	Trace	.21	.028	.004
497	"	Railroad well	66	55.00	"	Absent	.14	.029	.005
498	"	Salt springs	......	.37	"	"	.11	.010	.008
499	Marietta......	Salt lake	......	184.3	"	"	.16	.002	.006
500	Fairmont	A. H. Smith's well	60	3.3	Trace	Strong	.16	.0024	.016
501	"	Ed. T. Wade's	......	44.0	Marked	"	.66	.028	.035
502	"	T. R. Alstrom's	123	1.2	Trace	S. trace	.245	.041	.007
503	"	R. S. Jackson's	56½	.70	"	Absent	.700	.022	.007
504	"	E. J. Edward's	......	.60	"	Trace	......	.0526	.037
505	"	H. W. Sinclair's	125	.50	"	"	.11	.010†	.007
506	"	J. H. Gorman's	125	.70	Absent	"	1.46	.050†	.007
507	Dodge Center	Schoolhouse	60	14.0	S. trace	Strong	.24	.003	.006
508	Worthington	Shallow well, No. 1	20	3.25	Strong	V. strong	.46	.008	†.0155
509	"	Shallow well, No. 2	20	.700	"	Strong	.66	.007	†.018
510	Gr'd Meadow	Ice from Deer creek	......	.600	S. trace	Trace	.86	.0325	.030
511	"	Town pump	70	12.	"	Strong	.76	.020	.018
512	"	Greening's	84	.60	Absent	Marked	.35	.014	.010
513	"	Greening's bank	84	1.60	S. trace	S. trace	.36	.032	.014
514	"	W. G. Lockwood's	......	1.00	Trace	V. strong	.24	.005	.010
515	"	W. A. Natun's	......	1.8	S. trace	"	.34	.034	.016
516	Fairmont	Town supply	......	.400	Absent	Absent	.325	.016	.054
517	"	A. H. Norton's	130	.600	"	"	1.83	.070	.013
518	"	Sisseton lake	......	.450	Trace	"	.76	.01	†.050
519	"	H. Soudel's	60	.400	Absent	"	1.84	.040†	.017
520	"	E. Stowe's	100	.450	"	"	2.00	.062†	.048
521	Caledonia ...	Old town pump	82	9.0	Trace	Strong	.24	.012	.0054
522	"	Jail well	60	8.6	"	"	.36	.012	.006
523	"	J. Vossen's	68	17.5	"	"	.34	.0028	.012
524	Minneapolis..	Redfield's	40	.50	Absent	S. trace	.145	.003	.0045
525	Spring Grove	Shallow town well	95	5.75	"	Marked	.024	.002	.002
526	"	Deep well	400	3.4	"	"	.0496	.003	.002
527	St. Paul......	Spring in West St. Paul...	......	1.2	"	Strong	.062	.015†	†.016
528	St. Cloud.....	T. A. Dam's	21	26.5	Strong	V. strong	......	......	......
529	"	Second sample, No. 528....	21	20.5	"	Strong	.570	.014	.044
530	Minneapolis..	McCarthy's well	130	.800	Absent	Trace	.0868	.007	.016
531	"	McCarthy's tap	200	.60	Trace	"	.558	.108	.026
532	Preston	R. W. Rockwell's	14	5.8	"	Strong	.47	.014	†.042
533	"	Viall's	60	1.4	Marked	"	.76	.0074	.009
534	"	A. D. Gray's	65	.500	Strong	"	.412	.120	.030
535	"	A. Wayrock's	17	9.0	Marked	"	.214	.006	.009
536	"	D. Hardin's	16	4.5	Trace	Marked	.18	.006	.018
537	"	Thos. Flynn's	15	18.5	"	"	1.27	.012	.038
538	"	F. Rudd's	38	1.25	Absent	"	.04	.003	.006
539	"	Carrel's	15	3.7	Trace	"	.18	.066	.018
540	Adrian	Kanaranzi creek	......	.35	"	Trace	.24	.012	.016
541	"	Ice from Kanaranzi creek.	......	.30	S. trace	"	.211	.011	.009

† Plus.
‖ Uncertain.

LABORATORY ANALYSES—*Continued.*

Number.	Location.	Where Taken.	Depth, Feet.	Chlorine.	Nitrites.	Nitrates.	Consumed Oxygen.	Ammonia. Free.	Ammonia. Albu-minoid.
542	Albert Lea...	Town well..................	650	.25	S. trace	Absent	.148	.060	.005
543	"	Fountain lake ice..........	......	.30	Absent	Trace	.0186	.013	.0085
544	St. Paul......	Spring on Milwaukee R'y.	......	1.2	"	Strong	.0350	.068	†.022
545	"	Spring, No. 2..............	.....	.70	"	Marked	.235	.003	.008
546	Lake City....	C. Sinclair's ice...........	......	.20	Distinct	Trace	.42	.019	.014
547	"	Sinclair's ice, No. 2........	......	.25	"	"	.060	.013	.007
548	"	Sinclair's ice, No. 3........	......	.8	"	"	.06	.017	.009
549	"	Sinclair's ice, No. 4........	......	.3	"	"	.065	.013	.015
550	"	Lake Pepin water..........	......	.4	S. trace	"	1.155	.016	.022
551	"	Dr. Bayley's...............	......	1.3	Absent	Strong	.035	.001	.002
552	"	Melted ice, No. 5..........	......	.25	"	Absent	.014	.005	.009
553	"	Melted ice, No. 6..........	......	.25	S. trace	"	.007	.010	.009
554	Stephen......	G. W. Toomb's............	30	42.5	Trace	Trace	1.05	‡	.030
556	Dexter.......	F. P. Stout's...............	8	.30	Absent	Strong	.712	.010	.024
557	Elkton	L. S. Forde's...............	16	.30	"	Distinct	.162	.040	.008
558	"	G. Gildermeister's	75	1.80	Marked	Strong	.142	.016	.006
559	"	Town well..................	138	.35	"	Distinct	.168	.044	.013
560	Dodge Center	S. Langworth's............	35	3.7	"	V. strong	3.102	.032†	.032
561	Sleepy Eye...	Sleepy Eye lake............	......	.35	Absent	Absent	8.676	.037	.076
562	"	Cottonwood river	......	.25	Trace	Trace	‡.56	.024	.008
563	"	Cottonwood river ice......	......	.3	S. trace	Absent	.15	.009	.009
564	"	Cottonwood river, No. 3...	......	.35	Absent	S. trace	.660	.002	.005
565	St. Cloud.....	C. A. Cooper's.............	25	8.2	Marked	V. strong	2.04	.048	.080
566	Minneapolis..	McCarthy's................	130	.60	Absent	Trace	.12	.024†	.024
567	"	Washburn Home tank	......	1.0	Trace	Absent	.282	.020	.036
568	Warren......	Enoch Johnson's...........	......	38.0	Absent	Trace	.42	‡	.024
569	"	Grindelund's..............	180	1.6	"	"	.84	.024	.053
570	Gary..........	B. K. Stund's..............	......	2.3	Distinct	Strong	.30	.007	.014
571	Elbow Lake..	Town well..................	400	1.0	Absent	Absent	.222	.16	.006
572	Red Wing....	Mississippi river ice, No. 1	......	.25	"	"	.162	.011	.009
573	"	Mississippi river ice, No. 2	......	.25	"	"	.236	.005	†.035
574	Wykoff.......	Town supply, No. 1........	600	.45	Trace	"	.020	.009	.003
575	"	Town supply, No. 2........	......	.45	Absent	"	.026	.007	.005
576	Holden.......	T. A. Hoverstad's.........	76	.5	S. trace	Marked	......	.003	.012
577	Bellingham ..	R. K. Keene's	61½	.45	Strong	Absent	.204	.026	.015
578	"	Dr. R. K. Keene's, No. 2...	86	.90	Marked	S. trace	.197	.003	.012
579	"	Dr. R. K. Keene's, No. 3...	32	1.1	Absent	Trace	.204	.004	.026
580	"	Koppenis'..................	22	.70	Present	Present	.197	‡	.017
581	"	Hotel well..................	22	15.8	Trace	Marked	.344	.003	.026
582	"	Kanten's...................	32	.65	Absent	Trace	.344	.007	.007
583	Warren	E. Johnson's...............	16	3.6	Trace	"	.582	.014	‡
584	"	Senator Grundeland's.....	180	42.5	Absent	"	.30	‡	.016
585	Donaldson ...	J. J. Lind's.................	98	340.0	S. trace	Absent	1.21	‡	.026
586	Benson	Surface wells..............	......	4.26	"	"	.195	.0025	.008
587	"	Deep well..................	130	.520	Strong	Strong	.250	.104	.032
588	St. Cloud.....	A. Hussey's................	25	13.5	Marked	"	1.12	.015	‡
589	"	Town supply...............	......	.4	S. trace	Present	.786	.005	.026
590	Winsor	A. Johnson's...............	45	1.00	Absent	Trace	.021	‡	.011
591	Mankato	Town supply...............	550	.75	Marked	"	.0126	‡	.012
592	St. Cloud.....	Miss. river, town supply..	......	.4	Trace	Marked	.67	.007	.037
593	Litchfield.....	Town supply...............	44	2.5	Absent	Absent	.13	Absent	.004
594	Dodge Center	E. Kant	35	1.00	Marked	Marked	.125	.007	.005
595	Albert Lea...	W. A. Morin's..............	650	.25	Trace	S. trace	.33	.042	.007
596	St. Cloud.....	G. R. Crosby's.............	30	8.00	Absent	Strong	.98	.004	.013
597	Slayton	Marshall's.................	205	.500	"	Trace	.165	‡	.018
598	"	Marshall's, No. 2..........	500	.45	Strong	"	.15	.013	.014
599	Northfield ...	Scofield's..................	30	3.5	Marked	Strong	.125	.01	.022
600	Minneapolis..	Filtered Miss. river water	......	.35	Trace	Trace	.51	.013	.032
601	Anoka........	Hall's......................	25	2.5	"	"	.155	.006	†.016
602	Hanley Falls.	M. S. Larson's.............	250	22.0	Marked	"	.21	‡	.007
603	St. Paul......	H. Holbert's...............	......	.25	Absent	"	.12	Absent	.006
605	"	H. Holbert's, No. 2.........	......	.30	"	"	.11	.003	.009
606	Browns Val'y	Barrett's...................	......	14.0	Marked	"	.54	.015	.048
607	Duluth.......	Ice from Lake Superior...	......	.15	Absent	"	.255	.016	.022
608	New Ulm.....	Dr. Wessen's	206	.60	Trace	"	.73	.025	.015
609	Mankato	City supply................	550	.75	"	S. trace	.0095	High	Absent
610	"	City supply, No. 2.........	550	.75	"	"	.0097	High	Absent
611	Virginia......	Public supply..............	......	.60	Absent	Trace	.17	.005	.012
612	St. Cloud,....	State reformatory.........	77	1.1	"	"	.11	.004	.005
613	"	Town supply...............	......	.55	"	Absent	1.065	.015	.025
614	Faribault	Dr. Cool s spring	......	1.0	Trace	Trace	.235	.010	.009

† Plus.
‡ Excessive.

LABORATORY ANALYSES—*Continued.*

Number.	Location.	Where Taken.	Depth, Feet.	Chlorine.	Nitrites.	Nitrates.	Consumed Oxygen.	Ammonia.	
								Free.	Albu-minoid.
615	Northfield....	A. Keene's	45	.700	Trace	Strong	.05	.02	.005
616	Duluth	City ice	......	.25	Absent	Absent	.255	.016	.022
617	"	City ice, No. 2	......	.25	"	"	.03	.010	.004
618	"	City ice, No. 3	......	.25	"	"	.025	.002	.007
619	"	City ice, No. 4	25	.25	"	"	.02	.009	Absent
620	Alden	J. E. Stark's	37	27.0	Trace	V. strong	.12	.002	.017
621	New Ulm	Dr. Weiser's	......	.300	Absent	Trace	.09	‡	.005
622	St. Cloud	Town supply, No. 1	......	.30	Trace	Strong	2.4	.006	.020
623	"	Town supply, No. 2	......	.30	"	Marked	2.29	.008	.022
624	"	Town supply, No. 3	......	.25	Absent	"	2.3	.008	.022
625	"	Town supply, No. 4	......	.30	Trace	"	2.23	.008	.012
626	"	Town supply, No. 5	......	.25	Absent	Distinct	2.3	.008	.010
627	"	Town supply, No. 6	......	.25	"	"	2.38	.008	.018
628	"	Town supply, No. 7	......	.25	S. trace	"	2.34	.008	.016
629	"	Town supply, No. 8	......	.25	Absent	Marked	2.23	.008	.016
630	Lake City	Ice supply	......	.30	"	Absent	.94	.008	.026
631	"	Ice supply	......	.45	"	"	.975	.012	.026
632	"	Ice supply	......	.50	"	"	.935	.012	.032
633	"	Ice supply	......	.55	"	"	.985	.052	.024
634	"	Public well	......	1.2	"	Strong	.180	.012	.004
635	Owatonna	City supply	......	.95	S. trace	Marked	.42	.020	.006
636	St. Cloud	State reformatory	......	1.0	Absent	Absent	.21	Absent	.004
637	"	State reformatory	20	11.2	Trace	Strong	.36	.008	.018
638	Hopkins	Ice supply	......	.25	Present	"	1.14	.014	.010
639	Albert Lea	Dr. Belshem's	33	.5	Absent	Marked	1.75	.040	.040
640	Montevideo	Town supply	......	13.0	Strong	"	.455	‡	.032
641	Alexandria	H. Jenken's	35	8.4	V. strong	V. strong	.811	‡	.040
642	"	Hiebel's	42	2.5	Absent	Strong	.32	.010	.012
643	Olivia	New town well	349	1.2	"	Marked	1.83	‡	.036
644	Elbow Lake	W. E. Landeen's	......	.45	"	Strong	.214	.006	.012
645	Mankato	Town supply	......	.5	"	Present	.115	.070	.004
646	"	Dr. Holbrook's	18	1.2	Strong	"	.24	.038	.040
647	Sunrise	Swan Blitz's	18	.55	Trace	Strong	1.37	.030	.028
648	"	Creek	......	.20	Absent	Distinct	2.63	.026	.026
649	Cloquet	H. O. well	40	6.3	Distinct	Marked	.416	.014	.026
650	"	H. O. well, No. 2	28	1.9	Trace	"	.016	.036	.024
651	"	H. O. well, No. 3	24	4.5	Marked	Trace	.34	.012	.028
652	"	H. O. well, No. 4	12	4.1	"	"	.16	.022	.024
653	"	H. O. spring	......	.25	S. trace	Absent	.106	.005	.005
654	"	H. O. well, No. 5	12	18.4	Marked	Marked	.246	.010	.060
655	Randolph	J. C. Markham's	60	8.5	Absent	Trace	.416	.004	.024
656	Delano	High school	40	.25	"	Marked	.312	‡	.018
657	Owatonna	P. Sorenson's	32	.25	"	Trace	.412	‡	.030
658	Le Sueur	Dr. Dodge's	20	7.2	Strong	Marked	.216	‡	.018
659	Aitkin	Dr. Greaves'	......	.25	Absent	Trace	.114	.050	.006
660	Montevideo	M. E. Titus'	25	11.5	Marked	"	.214	.024	.020
661	"	Town supply	40	14.2	Trace	Marked	.824	‡	.040
662	"	Mill's	25	.3	Absent	Absent	.211	.004	.011
663	Windom	Town supply	20	.5	Trace	Trace	.312	.016	.018
664	St. Paul	Highland springs	......	.142	Absent	S. trace	.016	Absent	Absent
665	Mallory	R. Nesbit's	285	194.0	Trace	Strong	1.32	‡	.052
666	Pipestone	Tap at Calumet Hotel	......	2.95	Absent	"	.33	.001	.006
667	Nor. Branch	McClintock's	40	.14	"	Absent	.342	.025	.020
668	Madelia	Town supply	212	.14	Trace	Trace	.13	.013	.012
669	Lake Benton	Town supply	14	1.23	Absent	S. trace	.22	.003	.006
670	Deland	A. Horsch's	80	.180	S. trace	Trace	.105	.053	.005
671	Spring Valley	W. A. Hall's	52	1.4	Strong	Strong	.48	.024	.028
672	Litchfield	N. S. Hawkins'	20	.24	Absent	Absent	.08	.006	.015
673	Browns Val'y	Marshall's, No. 1	12	5.8	Marked	Strong	.612	.012	.016
674	"	Marshall's, No. 2	12	.855	Trace	Marked	.314	.013	.010
675	St. Cloud	Filtered Miss. river water	......	.15	Marked	Trace	.78	.028	.028
676	"	Miss. river at station tap	......	.15	Absent	"	.85	.026	.040
677	"	Spring near station	......	2.1	"	Strong	.26	.048	.020
678	"	Sauk river	......	.15	"	S. trace	.46	.024	.040
679	Browns Val'y	Schain spring	......	5.8	Marked	Strong	.612	.012	.016
680	"	Carter springs	......	.85	Trace	Marked	.314	.013	.010
681	Owatonna	Town supply	27	.24	Absent	Absent	.21	.040	.004
682	"	Town tap	......	.57	Trace	"	.312	Absent	.012
683	Lake Shetek	Lake Shetek	......	.095	Absent	S. trace	1.7	.025	.042
684	Tracy	Town well	......	1.52	"	Trace	.12	.005	.004
685	"	Tap at water works	......	2.2	Distinct	"	.34	.080	.008

† Plus.
‡ Excessive.

LABORATORY ANALYSES—*Continued.*

Number.	Location.	Where Taken.	Depth, Feet.	Chlorine.	Nitrites.	Nitrates.	Consumed Oxygen.	Ammonia.	
								Free.	Albu-minoid.
686	Cloquet	Dr. Allen's..................	30	1.8	Absent	Strong	......	......	......
687	"	H. O. well..................	10	7.2	Strong	"	......	......	......
688	"	H. O. spring..................	......	1.5	Distinct	"	.019	Absent	Absent
689	"	H. O. spring..................	......	1.6	Absent	"	.32	"	.036
690	"	H. O. well..................	30	3.1	Marked	"	.32	.012	.016
691	"	H. O. well..................	12	2.7	Absent	"	.42	.01	.006
692	"	H. O. well..................	27	5.3	S. trace	"	.32	......	.004
693	"	H. O. well..................	24	7.9	Trace	Trace	.42	.001	.009
694	"	H. O. well..................	26	3.6	Absent	"	.36	.003	.010
695	Montevideo ..	C. H. Budd's..................	42	.180	Marked	"	.32	.002	.004
696	"	L. A. Elwell's..................	32	.18	Absent	Absent	.32	.001	.007
697	"	G. G. Elvason's..........	45	3.9†	Trace	Trace	.36	.019	.020
698	"	E. B. Hubery's..................	67	.142	"	"	.37	.036	.022
699	"	H. E. Hoard's..................	31	3.9†	"	"	.042	.007	.011
700	"	L. G. Hayes'	60	3.91	"	S. trace	.028	.004	.012
701	"	E. B. Hubery's, No. 2.	67	3.9	S. trace	"	.022	.004	.010
702	"	H. Amundson's..................	34	.49	Absent	Absent	.036	.028	.017
703	"	F. M. Wolfe's..................	30	1.3	Marked	Strong	.42	.032	.028
704	"	H. L. Olson's..................	28	.7	Trace	Marked	.45	.040	.001
705	"	F. Tydeman's..................	30	1.84	Absent	Strong	.32	.003	.002
706	Northfield ...	J. R. Shelby's..................	40	1.04	Trace	"	.76	.006	.005
707	....	....	......	......	....	....	......	......	......
708	Eveleth	Dr. Moore's..................	......	.14	Absent	Absent	1.2	.007	.020
709	"	Dr. Moore's..................	......	3.6	Strong	Strong	.42	.058	.022
710	"	Dr. Moore's..................	......	4.1	Marked	Marked	.38	.020	.018

† Plus.
‡ Excessive.

The laboratory specimens for this report begin with No. 476, which was taken from the deep flowing city well at WINONA, said to be 500 feet deep. Other depths have also been given, ranging from 490 to 1,300 feet. The chlorine is high, as is also the free ammonia. Both, however, are admissible in a deep, salt district, well. The next specimen (No. 477) was taken from a deep flowing well near the above, but much of the water (probably most of it) comes from shallow depth. (See report by counties; also "Chlorine.") Nos. 478 and 479 were from flowing wells referred to under "Chlorine," and examined principally for ammonia. The above four wells were the only ammonia determinations made during the summer of 1899, on samples collected by ourselves.

No. 480 was from a deep high chlorine well at LAKE CITY railway station. The consumed oxygen is a trifle high, and presumably due somewhat to the large amount of iron present, as it is unusually free from organic ammonia. Nos. 481-483 were also taken in or near Lake City; the last two because of the popularity of the springs they represent. Nos. 484-488 and 490-491 represent important village supplies. Were we not familiar with the normal

water in Marshall, the two wells, Nos. 490 and 491, would of necessity be condemned, as theii analysis is unique for natural water, yet very common for that part of the state. The data are presumably due to sea mud and peat, not to the infiltration of animal pollution. No. 489 was taken from Lake Shetek, and is an example of high organic oxygen and organic ammonia from purely vegetable causation, as the lake receives no known pollution. Nos. 500-506 were examined by request of the health officer at FAIRMONT. They represent waters from tubular wells, from sixty to 125 feet deep, in yellow clay, blue clay and sand. Some of these wells were given a preliminary examination during the field work, and fresh samples were afterwards forwarded to the laboratory. A laboratory sample (No. 507) of the schoolhouse well at DODGE CENTER also gave confirmatory data. In this case we advised the abandonment of the school well, using the village supply instead.

Nos. 508 and 509 represent the analyses for the shallow WORTHINGTON wells. (See report by counties. *Nos. 68 and 69.) The data confirmed the field opinion. Nos. 510-515 represent samples sent, at our request, from Grand Meadow. They include the public water supply and the ice, both of which were suspicious in the field (F. A., Nos. 185-191), and condemned in the laboratory.

Water from Lake Budd (supplying the village of FAIRMONT), Lake Sisseton, which is connected with Lake Budd (F. A., Nos. 100 and 101), and three Fairmont private wells are included in Nos. 516-520.

Nos. 521-523 were sent from CALEDONIA, in compliance with our request. No. 522 was taken from the county jail water supply, which was polluted by a cesspool nearby.

No. 524 was taken from a fairly good driven well in MINNEAPOLIS.

Nos. 525 and 526 were taken from the SPRING GROVE wells, which furnish the village water supply. They pass through clay, limestone and sandstone to the blue clay again. I requested another sample of each, but none has yet been sent.

No. 527 was taken from a spring in WEST ST. PAUL.

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*Hereafter reference to these reports by county analyses will be designated as "F. A." (field analyses); see foot note on page 167.

Nos. 528 and 529 represent two samples from the same well in ST. CLOUD. Both analyses evidence contamination.

No. 530 was taken from a MINNEAPOLIS well, bored in sand, clay and gravel. The top of this well is high above all pollution, but the bottom is considerably below two cesspools. No. 531 was taken from the Washburn Home tap in MINNEAPOLIS. The tank is supplied by a mixture of water from a well and from Minnehaha creek. The data of these analyses are probably due to the waste from the beet sugar works, which finds its way into the creek above.

Nos. 532-539 were sent in by the health officer of PRESTON. They represent waters from dug and driven wells having depths varying from fifteen to sixty-five feet in sand, clay, gravel, and a little rock. The usual surroundings of village wells are in evidence, as shown by the pollution. Some of these wells were examined during the field survey. (F. A., Nos. 212-214).

As previously stated, a sample of the Kanaranzi creek and of the ice from it were sent in by Dr. Sullivan from ADRIAN. Their analyses are represented by Nos. 540 and 541. These point to the pollution of the ice supply of a large and flourishing community by a single farm. Said farm, however, is out of the Adrian health officer's district, and he is unable to stop the nuisance. Such conditions give eloquent evidence for the need of a state inspection of water and ice supplies.

Nos. 542 and 543 were sent by the health officer of ALBERT LEA. They represent, respectively, the city water and ice supplies, and bear out the field analyses (F. A., Nos. 151 and 147-159). It is instructive to note the variation in analyses between the Fountain Lake water, and ice cut from the same (F. A., No. 158, and Lab. Anal., No. 543). Nos. 544 and 545 represent springs from WEST ST. PAUL.

Nos. 546-550 represent samples taken from Lake Pepin, at different points, in order to determine the area of least contamination. The LAKE CITY ice supply is to be cut at the best point. No·551 represents the city well (LAKE CITY) referred to in the report by counties. Nos. 552 and 553 represent samples of the melted lake ice.

From STEPHEN, from a well thirty feet deep (No. 554), was sent on account of sickness among the stock, which were undoubtedly drinking bad water.

No. 556 was taken from a DEXTER cistern, and gave a very unusual analysis for rain water. The family were afflicted with typhoid fever, and we advised them to clean, disinfect and re-cement their cistern.

From ELKTON, samples 557-559 were sent in during a siege of typhoid. I requested a second sample from the first well, and condemned the other two.

A sample from another dug well was sent in from DODGE CENTER, on account of typhoid fever, and was also condemned (No. 560).

Nos. 561-565 were sent in from SLEEPY EYE. Sleepy Eye lake (No. 561) is the main source of supply for ice, with outhouses but ten feet distant from its banks. No. 562 was from Cottonwood river, with dead hogs in the water above the point where the sample was taken. This is also a source of ice supply. Both waters were condemned.

Nos. 563 and 564 represent ice taken at different points in the COTTONWOOD RIVER.

No. 565 was taken from a ST. CLOUD driven well, some twenty-five feet in sand and gravel.

Nos. 566 and 567 represent second samples from certain MINNEAPOLIS waters, taken to verify the suspicion of pollution.

Nos. 568 and 569 represent two WARREN wells, of which but small samples were sent. Larger samples were asked for.

No. 570 was taken from a well at Gary, with no data as to the soil, environment, etc.

The ELBOW LAKE village well is some 400 feet deep, and a chemically good sample (No. 571).

Nos. 572 and 573 are samples of Mississippi water, taken at RED WING.

The new WYKOFF wells, previously referred to, are 600 feet deep, and in good location. The analytical data are likewise favorable (Nos. 574 and 575).

No. 576 was taken from a driven well at HOLDEN. The family was troubled with remittant fever, and the environment of the well was unfavorable. We advised boiling the water and sending a second sample to the laboratory.

The BELLINGHAM samples (Nos 577-583) are from bored and dug wells, ranging in depth from sixteen to eighty-four feet, in loam, yellow clay, blue clay and gravel, with the usual environment.

Second set of samples from WARREN, already referred to, were analyzed (Nos. 583 and 584). Mr. Johnson's is a dug well (No. 583), in loam, sand and clay, with a stable thirty feet distant; consequently it is not a natural surface water. Mr. Grindeland's, however, is 180 feet deep, and may be (probably is) a typical Red River Valley flowing well (No. 584). The excessive chlorine of this latter sample, and the absolutely enormous chlorine of No. 585, taken from a Kittson county flowing well, ninety-eight feet deep, suggests the strong probability that they are both located in an area either of saltiferous rock, or possibly an extension of the "sea mud," which apparently overlies the granite in Lac qui Parle county The lack of any positive knowledge as to the salt normal of these counties entirely nullifies the chlorine as a sanitary guide, and final judgment on either or both of these wells could be rendered only after an examination of similar waters in the close neighborhood.

Nos. 586 and 587 represent BENSON village wells. No. 586 was a mixture of fourteen surface waters, in the drift. Environment was not good, and the chlorine is high. The second sample likewise gave impossible data for good water. A barn was within fifty feet of the place where it was taken. There were six typhoid fever cases in the families using this water at the time the sample was taken.

No. 588 was taken from a dug well in ST. CLOUD, with the outhouse but eighteen feet distant. A previous examination of this water had been made, with similar data.

No. 589 was taken from a private tap in ST. CLOUD, and represents river water.

No. 590 was a WINDSOR, Beltrami county, specimen from a flowing well, forty-five feet deep, in sand and gravel. It was considered passable for a flowing water.

The MANKATO artesian well is bored 550 feet (drift, ninety feet; sandstone, 400), with no contamination near. The sample, however, gave a peculiar analysis (No. 591), and the opinion given was, in part, as follows: "Analysis shows a past history of contamination, as evidenced by free ammonia and nitrates. The nitrites, however, evidence some recent source of pollution, and I should advise searching for it." The supposition was that the water had been taken directly from the well, according to the directions for collection; but it seems the tap water was sent instead. Shortly after this analysis, the city tank, a ground-surface structure, was cleaned, and, in the words of the health officer, "A number of drowned rats were found in the tank." Samples direct from the well were then sent, which yielded good water data. (See Nos. 609 and 610.)

No. 592 represents another sample from the Mississippi river at ST. CLOUD.

The LITCHFIELD sample (No. 593) was a mixture from twenty-six driven wells, in white sand, eighteen feet; gravel, six feet; blue clay, twenty feet; gravel, six feet. The nearest cess-pool is 600 feet. The analysis being unusual, the following opinion was sent: "The chlorine of this water is considerably higher than the hitherto accepted 'normal' for this state,—i. e., one part; otherwise the analysis is so good that the chlorine may be due to natural saltiferous soil. If you care to send me half a dozen samples of other typical wells in the district, it will materially assist in clearing up this point and forming an opinion."

No. 594 was taken from a DODGE CENTER dug well, and was sent in because of sickness among the cattle. The well was dug in the barnyard, and the manure pile was within fifty feet.

No. 595 represents another sample of the ALBERT LEA city flowing well.

No. 596 represents another ST. CLOUD dug well, located between the river and an outhouse.

No. 597 was taken from the new drilled well at SLAYTON. This sample, and one marked "500-foot well," were sent in to determine whether or not the drilling should go deeper. The samples came in jugs. The following opinion was given: "I cannot recommend this as a city supply with such high ammonias, and would advise going deeper. I have, of course, no knowledge as to how the jugs were prepared for the collection of the samples. Unless they were perfectly clean, the analysis would have no meaning. I mention this because I found pieces of hay in the jug marked '500-foot well.'" The data for this well (No. 598) were unfair, by reason of the aforesaid hay.

No. 599 was from a NORTHFIELD well, thirty feet deep, with an outhouse thirty feet distant.

No. 600 was taken from a MINNEAPOLIS tap. The water passed through a Jewel filter.

No. 601 was taken from an ANOKA dug well, in sandy soil, with outhouse and barn seventy-five feet distant. Typhoid and winter cholera had existed among those who used this water.

No. 602 was taken from the HANLEY FALLS drilled well, 250 feet deep, the nearest contamination being 300 feet distant. Our opinion at the time of analysis was as follows: "Analysis evidences organic pollution of the water, as shown by the chlorine nitrates and free ammonia. If you wish another examination made, I will forward another bottle for collection." An analysis of this same well was made during the field work, and practically the same data were obtained, but the opinion was no longer the same, because the natural water for the district in which Hanley Falls is situated exhibits a natural high chlorine and trace of nitrous acid. The free ammonia likewise is excessive in samples examined, as should probably be expected from "sea mud" and "peat." (See report by counties, under Yellow Medicine county. This is a most instructive lesson in the necessity for a sanitary study of Minnesota waters.

Nos. 604 and 605 represent two spring waters sent from ST. PAUL.

No. 606 represents a BROWNS VALLEY water, but no describing data were sent, even on request; therefore no opinion was formulated.

No. 607 represents an ice specimen from Lake Superior, about 100 yards off the shore, at DULUTH. A sewer enters some 300 yards from the cut. Advised cutting further out.

No. 608 represents water from a tubular well at NEW ULM, 206 feet deep. Another sample was requested, and sent. The data is given under No. 622.

No. 609 represents a second analysis of the MANKATO city water, and No. 610 is apparently from the same well.

The VIRGINIA spring (No. 611) supplies the village, including 300 miners. It is located in the valley, near a lake which receives the Virginia sewage. The following opinion was sent: "The general analysis is fairly passable. Albuminoid ammonia is, however, a little high for spring water. Taking the environment into consideration, I should judge the supply is in danger of contamination, and that it would be well to examine it at intervals of from two to three months."

No. 612 represents the first analysis of the state reformatory well at ST. CLOUD, dug seventy-seven feet in hardpan, with quicksand runs and a quicksand bottom. The barn is 150 feet distant, on higher ground. In our opinion the water was suspicious, and another examination was recommended.

No. 613 was taken from the ST. CLOUD city supply, at the intake pipe, 150 feet above the city sewer. The following opinion was sent: "Analysis shows evidence of pollution. This is the third examination of the Mississippi water at St. Cloud made recently, and each one demonstrates contamination of varied nature."

No. 614 was taken from a FARIBAULT spring.

No. 615 was taken from a NORTHFIELD driven well, forty-five feet deep, in gravel. It has the following environment: Cemented outhouse, twelve feet, common vault, sixty feet; barn, seventy feet; cesspools, seventy and eighty feet distant. Typhoid and scarlet fever exist in the family.

The health department of DULUTH sent in four samples of Lake Superior ice. No. 616 was cut 100 yards off shore, at the foot of Twenty-first Avenue East. A sewer discharges 300 feet away, and

there are a number of barns and outhouses on the shore. No. 617 came from the vicinity of Lakewood, four miles from Duluth. No. 618 was cut from the Duluth reservoir, the water coming from the Lakewood station. No. 619 was taken at the foot of Twenty-third Avenue East, 200 yards off shore, in twenty-five feet of water, and a quarter of a mile from the sewer. Our opinion was adverse to No. 616, and favorable to the others.

No. 620 was taken from a bored well in ALDEN, with an outhouse twenty-five feet distant.

No. 622 represents a second sample of the NEW ULM water (No. 608).

Nos. 622-629 represent a series of Mississippi samples, taken at ST. CLOUD. The river at this point is restrained by a large dam, and its waters form practically a lake. The sewer empties into the river above this dam, and the city supply is taken from this same body of water into which the sewer discharges. Both old and new intakes drink from the dammed waters, and the new sewer runs in between said intakes. No. 622 was taken from a tap in the Grand Central Hotel, St. Cloud. No. 623 was taken from near the newly constructed intake pipe, about 150 feet above the sewer, St. Cloud. At the time of sampling a fairly strong wind was blowing up stream, and the sewage was carried by this wind a considerable distance, visible to the eye. Nos. 624-628 were taken at intervals of about 150 feet up stream from the new intake at St. Cloud. No. 629 was taken 1,000 feet above the said intake. The series gives excellent evidence of the varying pollution of the Mississippi river, due to up-stream sewers and contaminated tributaries.

LAKE CITY. A few more samples of the river were taken in Lake Pepin, at the request of a local ice dealer. No. 630 was taken from the current in the lake, and was the least polluted of the series. No. 631 was taken a short distance below No. 630, but out of the current. No. 632 was taken from a bay in the lake, and near the previously mentioned slough (see F. A.) No. 633 was taken from a point half way between the pier and the recently constructed sewer, and this is plainly evidenced by the free ammonia and the chlorine present. No. 634 was taken from the Lake City public supply, previously referred to (F. A., No. 521), and shows the effects of infiltration from the town.

No. 635 was from the OWATONNA tank, a mixture of waters

from wells twenty, eighty and 465 feet deep, and from a gallery with old pine curbing (see report by counties).

Nos. 636 and 637 were taken from the state reformatory wells, which were inspected during our visit at ST. CLOUD. No. 637 was taken from a dug well, twenty feet deep, in sand, with wood curb. The pump stands in a small, three-sided inclosure, and is apparently clean; but unfortunately the sides of said inclosure are near the fences of extensive cattle yards. The intention was to use this water for the reformatory, but both the environment and analysis were distinctly against such action. No. 636 represents the dug well previously referred to (Lab. Anal., No. 612). The only objectionable feature is the chlorine, and we have no means of knowing whether or not that is normal. Presumably some may come from the barns.

No. 638 was taken from a small lake near HOPKINS, Hennepin county. Eight loads of grain were dumped into it last year, and ice was then cut during the winter. The health officer at Hopkins wished to prevent the use of this ice at a large Fourth of July picnic, and the analysis evidenced that his suspicions were correct.

No. 639 represents a dug and drilled (?) well, from ALBERT LEA, in loam, three feet; sand, ten feet; gravel, twenty feet. Cesspool, fifty feet distant. Typhoid fever in the family.

No. 640 represents the laboratory sample of the MONTEVIDEO water supply. The following opinion was sent: "This water is heavily charged with polluting organic matter, as evidenced by every sanitary test applied. It is absolutely unfit for domestic use." Another sample was sent later, and the same opinion given again. Whether or not the supply remains the same I cannot say, as we have no athority which would secure attention to our opinions or action on our advice.

Nos. 641 and 642 represent ALEXANDRIA samples, from bored wells, with "handy" outhouses and barns.

Sample from OLIVIA'S new public supply was sent to the laboratory in a jug, very poorly corked, and with two old corks floating inside. The depth given was 349 feet, but no data as to stratification. We are not familiar with the normal waters of Renville county, and moreover the sample was not a fair one. The following statement was sent: "The above data are not satisfactory, and I wish

to make another analysis before stating any opinion. I forward a sample bottle to you to-day (July 6, 1900,) by express." The bottle has not yet been returned (Nov. 14, 1900,) and nothing further heard from the town.

No. 644 was taken from a spring at ELBOW LAKE.

A third analysis of MANKATO city water yielded much better data than previous examinations, and presumably the conditions are now good (No. 645). A surface well, in Mankato, with an outhouse fifty feet distant, yielded the normal data for those conditions (No. 646).

No. 647 was taken from the poor farm well at SUNRISE. It is a surface water, and although the source of contamination is unknown, it yields accusing data. There have been five cases of typhoid at this poor farm in two years. The creek at Sunrise is connected in some way with the well, and helps to pollute it, or *vice versa* (No. 648).

Nos. 649-652 and 654 represent dug wells from CLOQUET. They pass through from twelve to forty feet of clay, gravel and slate rock. Nos. 649-651 were used by typhoid fever patients. The wells have the usual environment of cesspools, etc., and the worst of the lot (No. 654) represents the village supply, recently put in. This well is dug in four feet of clay and eight feet of slate rock. It has a livery stable and an outhouse sixty feet and a second outhouse 100 feet distant. It was closed by the action of the health officer.

No. 655 was sent in from RANDOLPH. Much pollution surrounds it, which, by evidence of the analytical data, reaches the well.

No. 656 was taken from the DELANO school well, some seventy feet deep, in gravel. The school closet is within twenty-five feet of the well, and another old closet "nearer." The children were drinking polluted water.

No. 657 was taken from an OWATONNA dug well, thirty-two feet deep. Hog house five feet distant. Reason for asking an analysis was given that typhoid fever, bowel trouble and pneomonia existed among those using the water. The data condemned.

No. 658 was sent in as suspicious by the health officer at LE SUEUR. It represents a dug well, some twenty feet deep, and the

surface ground is low and marshy. Stock yards were near, on higher ground. The theory of pollution was supported by chemical examination.

No. 659 represents a spring at AITKIN. It was sent as a possible public supply. No contaminating conditions were known. The following opinion was given: "Sample is fairly passable for a spring water. However, the free ammonia shows that the water in the past has been polluted. If this is to be used as a domestic supply, I would advise a succession of analyses in order to demonstrate continued purity."

The three MONTEVIDEO samples (Nos. 660-662) represent two private dug wells and another sample of the public supply. No. 660 represents a well that is evidently polluted by its environing outhouses. No. 662 represents at present a passable supply. With reference to the Montevideo village well the following opinion was given: "This second analysis of the village supply again shows decided pollution. The water is not fit for public use."

No. 663 represents the WINDOM supply referred to in the field work. The following opinion was given: "Analysis evidences contamination, as shown especially by the ammonias. Would advise removal of the outhouse, cleaning and disinfecting of the vault. Likewise that the eighty-foot points be refitted for use, and that the bottom of the cistern be cemented or bricked, save at the point orifices."

No. 664 is another sample of an unusually excellent ST. PAUL spring. This was made after cleaning out some leaves which had accumulated in the bottom of the spring basin.

No. 665 represents a small sample from MALLORY. No data either as to soil or environment were sent, and the analysis was decidedly objectionable. Mallory is in Polk county, near the Red River of the North. The chlorine of that county is as yet undetermined.

The PIPESTONE sample (No. 666) represents mixed waters from two wells. They are respectively 196 and 340 feet deep, passing through loam (two feet), clay (twenty-five feet), and the balance quartzite, including probably some pipestone. The nearest source of possible contamination is a cesspool, some 250 feet distant. We will make occasional examinations of this water.

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No. 667 was taken from a dug well at NORTH BRANCH, but was not sent in a laboratory bottle.

No. 668 represents the MADELIA village supply referred to previously (F. A., No. 790). The nearest outhouse is 150 feet distant. We advised an occasional examination.

No. 669 was taken from the LAKE BENTON village well, in sand and gravel, described under "Lincoln county," in report by counties.

No. 670 represents a DELANO driven well, eighty feet in sand and gravel. An outhouse is sixty feet and a barn 100 feet distant.

No. 671 was taken from a SPRING VALLEY well, fifty-two feet deep. It has outhouses near by.

No. 672 was taken from the LITCHFIELD driven well.

Nos. 673 and 674 were taken from BROWNS VALLEY dug wells, some twelve feet deep. The first is the village supply, and was evidently polluted.

Of the ST. CLOUD samples (Nos. 675-678), the first is from the filtered river water, the second from the water-works tap, the third from a spring near the station, the fourth from the Sauk river (which receives varied contamination on its way down to the Mississippi).

Nos. 679 and 680 represent two BROWNS VALLEY springs, sent in without data, further than to state that they were spring waters.

The two OWATONNA samples, Nos. 681 and 682, were sent in as the same water, but from the well direct (No. 681), and from the tap (No. 682). The well itself is twenty-seven feet deep, with an old, suspected sewer some 400 feet, a dwelling, etc., 150 feet distant. The analytical data were so diverse that the tank water must be a mixture. Our opinion as to the dug well was adverse.

The LAKE SHETEK sample (No. 683) gives an instructive analysis of a lake water yielding a high ammonia and consumed oxygen, due to vegetation. It is another example of the necessity for personal inspection as well as chemical analysis.

The TRACY samples, from the well direct and from the tank, showing the pollution of the latter, were referred to in field analyses for Lyon county. Their ammonias are also given under Nos. 684 and 685.

Another series of samples from CLOQUET represent two springs (Nos. 688-689), and seven dug or driven wells ranging from twelve to thirty feet in depth (Nos. 686-687 and 600-694). One well (No. 687) is in slate. The others are in sand, gravel and some clay. The usual domestic environment prevails.

Eleven samples (Nos. 695-705) of domestic wells were sent in from MONTEVIDEO shortly after the condemning of the public supply. Similarly to the Cloquet waters, these were chiefly from shallow wells, dug or bored in sand, gravel and clay with vaults and cesspools in close proximity. One (No. 696) was considered fairly pure water. This is the usual resultant of dug wells in inhabited districts.

No. 706 was taken from a NORTHFIELD driven well, forty feet deep, with a cesspool fifteen feet distant. The users were afflicted with typhoid fever, and the well condemned.

No. 707 was taken from a lake near SPARTA, St. Louis county, and used as the town supply. No other description was sent, but may come later. The water is probably good.

Nos. 708-710 represent dug wells in EVELETH. Considerable typhoid fever prevails in the families using these waters. No other descriptions were necessary in the face of the data.

This closes the series of laboratory analyses up to Sept. 20, 1900.

SPECIAL CHEMICAL ANALYSIS.

1. In two cases, quantitative determinations of mineral residues were made by special request. Such analyses, while very interesting, are, at the present stage of knowledge, of but little service from the purely sanitary point of view.

A large mineral residue is of course undesirable but until the subject of the effect of such salts on the human animal economy is better understood, and until we can state more positively that such effect is pernicious, we shall be constrained to limit the condemning data to the organic rather than the inorganic.

However, the following estimations have been made reserving any pronounced opinion:

FLOWING WELL AT WARREN—MR. GRUNDELAND.

	Parts per 100,000 of Water.
Silicon oxide	2.1
Calcium oxide	21.2
Magnesium oxide	17.5
Sulphuric acid	16.6

MANKATO CITY SUPPLY.

	Parts per 100,000 of Water.
Silicon oxide	1.1
Iron and aluminium oxide	Trace
Calcium oxide	36.4
Magnesium oxide	14.
Sulphuric acid (solution)	8.8

The Mankato determination was made from water taken out of the tank. (See Lab. Anal., No. 591.)

In a few other cases the total and volatile residues were determined, but not as a rule, on account chiefly of the lack of platinum ware.

THE NORMAL CHLORINE IN MINNESOTA.

As a direct index to sewage contamination, the determination of chlorine is the most reliable datum of sanitary water analysis.

The value of the test is apparent when we remember that normal urine contains about one per cent of chlorides, which pass unchanged into any water supply subject to its infiltration. Thus, it is evident that waters contaminated by urine will yield increased chlorine.

But any decision that the chlorides of a certain water are in excess postulates a previous exact knowledge as to what constituted the normal or natural salt of that water. Theoretically, an inland state like Minnesota, far removed from the seas, should yield a constant normal chlorine from border to border, and that constant should be very small. High chlorine should come only from past or present pollution, and should be viewed complacently only in very deep wells, where its presence would signify ancient pollution, and when the analysis would give further evidence that said pollution was completely oxidized.

However, such conditions, unfortunately for the analyst, do not prevail in Minnesota. Rather, indeed, the widest divergence from such conditions is in increasing evidence.

Geology tells us that, many centuries ago, long before even the glacial epochs, a great depression of the North American continent submerged our state below the level of the sea. Only a few islands of ancient archean rock constituted dry land over the area of Minnesota. I refer to the latter part of the mesozoic age, reckoned as some six million years ago. For some three millions of years this so-called cretaceous ocean prevailed, and during that time cretaceous shales were laid down, consisting chiefly of clays, marls and limestones. Finally, however, by a gradual unlifting of continental areas, tract after tract was added to the land, until ultimately the salt waters had receded and dry land prevailed.

Even antedating the cretaceous era was a yet earlier known period of depression and another submerging of the continent beneath the salt waters. This (the Cambrian sea) is reckoned as beginning some twenty-seven millions of years ago, or in the first part of the paleozoic period. It probably endured some four millions

of years, or up to Devonian time. During this eon the Potsdam rocks were laid down.

There are, moreover, undoubted geological evidences that in the endless ages of the earth's history preceding the paleozoic period, the salt waters, time and again, swallowed up the land areas of the North American continent.

After finally emerging from the cretaceous ocean, the continent continued to elevate until high above the frost altitudes. Then came the glaciers, with their tremendous moraines, which, on the recession of the ice, covered the land with drift of vastly varying proportions. Ever since glacial time the active agents of erosion, air, frost and water have been at work, changing the face of the land, wearing away the drift, and carving the rock formations.

It will thus be manifest that the determination of what constitutes chlorine in Minnesota is a problem of great magnitude, and one which involves a study of geological areas, as well as the interpretation of chemical data.

Inferentially, the salt seas, in receding, left behind them memorials in the shape of saltiferous deposits, and it is those deposits, their location, depth and area, which form the problem we are endeavoring to solve. Such is the working theory which only time and the completion of our survey will enable us to verify or disprove.

At present date we have, in isolated areas, determined certain high chlorine districts. We are, of course, able to use only what is already prepared for us by nature and man, in the shape of wells, springs, rivers and lakes, and consequently may have passed over much chlorine territory which the shallow wells failed to reveal, and which deeper wells of the future may evidence. If money were available, the only positive method to determine the chlorine, absolutely, for all depths, in a county, would be through the drilling of deep wells, and the analysis of water samples from the various depths of water-bearing strata. This, of course, is out of the question, and we must accept the limitations to our knowledge imposed by existing conditions.

From Rock county to eastern Fillmore, we made examination of 225 samples of deep and shallow wells, springs, lakes and streams. Of these, sixty-seven specimens, scattered among the eight counties, yielded a chlorine of .208 parts to 100,000. Many other exceptionally good waters gave .312 or .416. However, inasmuch as the figure .208 presents itself with unvarying regularity from end to end of this district, sometimes in isolated waters, often

in groups, we may be permitted at this time to assume that the purely natural chlorine of this part of the state is .208 for all except waters of extraordinary depth.

Very deep wells, however, are likely to yield salty water, as evidenced by the drilling at Blue Earth City, Faribault county, where at a depth of 1,400 feet the water was an undrinkable brine, according to the statement of the authorities. The drilling was then filled up to 1,250 feet, and at this yet great distance below the surface a chlorine of .312 was found.

In northeastern Fillmore county, in the vicinity of Rushford, the normal began to change. The town well, drilled to 285 feet, and passing through considerable green slate rock, gives 1.04 parts. As previously stated, this well is situated 150 feet up the steep side of a bare rock outcrop, and would seem to be almost impossible of pollution. Northeast of Rushford, in Fillmore county, and passing into Houston county by way of Money Creek village, a number of deep ridge wells (Nos. 285 to 290) gave a prevailing chlorine of .312. Likewise, one valley well, at 150 feet, in Money Creek village, yield the same figure (No· 291). This datum is again found in the wells approaching Rushford by the south road from Houston (Nos. 280 to 282). However, here again in a small creek six miles east of Rushford (No. 279), and in a drilled ridge well, 150 feet deep, the old quantity, .208 was found. It again appears in another spring, in low ground three miles northeast of Rushford (No. 284), and likewise in a shallow well, one and one-half miles west of Rushford (No·378); and in a drilled valley well, 118 feet deep, one and one-half miles northeast of Rushford (No. 368). The deeper wells, especially those considerably above the Root river bottom, yielded from .312 up (Dr. Magnesson's samples Nos. 368-379).

Thus the deep ridge wells in the vicinity of Rushford appear to yield a .312 chlorine, while the springs and other valley waters give .208. The village supply is the only sample giving a high salt of presumably natural occurrence.

Houston Village, Houston county, is in the heart of a high salt district. The large number of flowing wells within the corporation limits, and the still larger number in the environing country greatly facilitated the work.

In Houston itself twenty-eight flowing wells showed high chlorine (Nos. 240-260). These wells range in depth between 230 and 310 feet, and, roughly speaking, the deeper the well the greater the

salt. The depths were obtained from local drillers. The shallowest well and the one yielding the least chlorine is represented by sample No. 262, with a depth of 230 feet and a chlorine of 4.42 parts per 100,000. From this quantity there is a varying assortment of figures up to 18.72 parts per 100,000 in a well 339 feet deep (No. 265). Reference to the depth column will show that this is the deepest drilling on the list. It would thus seem that we have a constantly increasing chlorine from the more shallow wells downward. Several of the data, however, do not entirely agree. This may possibly be due to incorrect depths given, because as an entity the statement holds. Note for example the identical chlorine, in Nos. 244-247, 252 and 253, which are from wells very near each other, and yet were given different depths. On the other hand, this variation in depth may possibly be due to a dip in the stratified rock.

Out of the village of Houston drives were made covering six directions. First, we studied the wells obtainable from Houston to Rushford, by the road running south of the Chicago, Milwaukee & St. Paul Railroad. The first two taken (Nos. 269-270) were somewhat of a puzzle, as they are of practically the same depth, and are located within a hundred feet of each other, yet one has much more chlorine than the other. Either the given depths were wrong, or there is a sudden dip in the rock at this point. Presumably, however, the sample (No. 270) is of considerably greater depth than 260 feet, as other wells within a short distance and of similar depth yielded results in accord with No. 269.

No. 271 was taken from a well one-fourth of a mile west of Rank's (No. 270), which was said to have a depth of 290 feet (chlorine 1.82). A mile further on another flowing well, 256 feet deep, had the same data as No. 269 (2.6). Previous to this no stratification was obtainable on this road. Here we were given loam, sand and sandstone as data. However, at the well where No. 273 was obtained, half a mile beyond, better data were obtained,—loam and sand, three feet; clay, seventy-seven feet; rock, 220 feet. The kind of rock was not known, but probably it is sandstone. Nos. 274 to 278 were taken from wells at a distance respectively of two, two and one-half, three, four and one-half and five miles west of Houston, which brought us within seven miles of Rushford. No. 278 was the last sample taken in this series which gave much chlorine, and even this quantity (1.04) was small compared with the Houston village wells. It will be noticed, however, that the figures for Nos. 277-278 and the Rushford village well (No. 276) are identical. With

No. 279, taken from Daley creek, the chlorine suddenly dropped, and continued low until we reached Rushford. However, that may be accounted for by the fact that, save in No. 280, there were no more flowing wells to examine, and the two drilled wells (represented by Nos. 282-283) were both comparatively shallow and located on elevations, and hence did not tap the flowing stratum. No. 280 is an uncertainty. The depth of the well from which it was taken was given at the farm as 215 feet, but this was discredited in the village, where a much lower depth (150 feet) was given. If this latter figure is correct, it accounts for the low chlorine (.312), and would tally with the wells of similar depth in the vicinity. On the other hand, if the farmer's statements were correct, it would mean that the chlorine district was delimited east of this point,—four and one-half miles east of Rushford.

Coming back by a northern detour, we could learn of no flowing wells in the valleys, consequently we took the ridge road to Money Creek village. The examination of these deep ridge wells has been reported as yielding a .312 datum. (See Nos. 285, 288-289, 290, 291.)

Two miles southeast of Money Creek village, which is some six miles north of a railroad station by the same name, we again encountered flowing wells with high salt. The first was located on a side hill of Money Creek valley, and passed 325 feet through clay and quicksand to eighty feet and the balance rock (No. 294). Chlorine 1.75, with no contamination visible. Another well (represented by No. 295) was located on the same premises, but on much lower ground and passed through much less rock (clay, ninety feet; rock, 110 feet); nevertheless it gave a somewhat higher chlorine figure (2.75 parts). About a quarter of a mile further on a flowing well, 440 feet deep, gave a datum somewhat similar to the deeper wells in Houston village (14.04 parts chlorine). Nos. 297 to 299 were in close proximity to each other, and like the two preceding were valley wells. The increase in depth again produced a corresponding increase in salt. Here, however, the wells were relatively considerably deeper than those in Houston, and would suggest a gradual dip from Houston northward. The last well on this valley road (represented by No. 300) was some two miles northwest of Houston, and passed through 106 feet of clay and sand and 159 feet of rock (chlorine 3.9).

Going west by northwest to Money Creek station, one deep drilled and four deep flowing well samples were secured. These were heard of later, and consequently their list numbers are higher. They present an interesting variation. No. 342 was taken from a

300-foot well, about five miles from Houston (west by northwest), located at the base of a bluff, and its organic data as taken are unusually good. Its chlorine is 2.34 parts.

No. 343 was taken about 600 feet from No. 342, and from a well twenty-five feet deeper, likewise in a valley. Its chlorine yield, however, is about one-third that of No. 342 (.78). One-fourth mile east of the well where No. 343 was taken, is another flowing well (represented by No. 344), in similar location and of the same depth, yielding the same chlorine (.78), and its neighbor, a drilled well not more than 800 feet away (represented by No. 345), yields still less, at a depth of 420 feet (chlorine, .416). The top of this well is eighty feet above the one represented by No. 344. About 600 feet from the well represented by No. 345 is yet another flowing well, giving the highest chlorine of this Money Creek station series (No. 346; chlorine, 3.4). Such data would indicate two water strata, very near each other, yet coming from very different sources.

No. 347 was taken from a well just across the Root river from Houston, and near the Old Mill well (No. 257). Turning toward the east, we drove from Houston on the south river road to Mound Prairie, thence by the north river road to Hokah. Chlorine apparatus and chemicals were taken along, and nothing but that element determined on the out road.

The south fork of the Root river (represented by No. 301) gave a high river chlorine one-fourth mile east of Houston village limits (.88). The first flowing well (represented by No. 302) was one and a half miles east on low land, in the valley of the Root river. The depth of this well was unknown, but its salt (16.9 parts) corresponds to the deeper Houston wells. The depth of the well represented by sample No. 303 was given as "about" 160 feet, and is some two miles east of Houston (chlorine, 13.52).

One mile northeast of the well represented by No. 303 another flowing well, some 210 feet in loam, clay and rock, yielded a chlorine similar to wells of about that depth in the village (No. 304; chlorine, 5.72). No. 305 was taken from a well two and one-fourth miles northeast of the well represented by No. 303, and is but 150 feet deep, yet it gives a somewhat higher figure than No. 304 (chlorine, 6.24). Sample No. 306 was from a well, 272 feet deep, three and one-half miles east by northeast from Houston (chlorine, 7.8). It passes but three feet of sand, and the balance (269 feet) of sandstone (?). This particular location is of interest, by reason of the tremendous dip of the sandstone. The well (in 269 feet of rock) is a few feet from the Root river. Across this narrow stream an-

other well was driven 100 feet in clay. A sample was not obtainable from this well. Half a mile further east a drilled well, 400 feet deep (represented by No. 307), with unknown soil and subsoil, gave a diminished chlorine of .88. One mile beyond, this quantity was duplicated in a flowing well, 390 feet deep, represented by No. 308. Five and one-half miles east of Houston another flowing well was sampled, but this one passed through sand and gravel, with no rock. It was a valley well, but gave the normal chlorine of the ridges (.312). Presumably it is a similar water, and would be drilled to in said deep ridge wells. In Mound Prairie two flowing waters, in near proximity and of practically the same depth, yielded some what different chlorine, yet both were comparatively low (Nos. 310-311; chlorine, .65 and 1.04). Drilled well sample No. 312 should be disregarded, as it was taken from unfavorable environment. No. 313 represents another drilled well in the uplands, one mile northeast of Mound Prairie (chlorine, .312). No. 314 represents a flowing well, drilled through 112 feet of clay and 185 of sandstone. It yields practically the same chlorine as Nos. 307-308, and is located one and one-half miles east of Mound Prairie (chlorine, .90). No. 315 was from a flowing well some four miles west of Hokah. The rock is unknown. The depth is 296 feet, and the high chlorine has entirely disappeared (.312). The same datum prevails in another similar well, passing 223 feet through sand, clay and rock (No. 317).

The Hokah village well is driven and drilled 534 feet in clay, claystone, limestone and sandstone to granite. Its chlorine (.708.) is a little higher than that of the environing wells, but could scarcely be considered abnormal for water from such a depth (No. 317). We returned from Hokah to Mound Prairie by the south road, and from Mound Prairie to Houston by the north road. A large spring (represented by No. 318), three and one-half miles southwest of Hokah, gave .416 parts chlorine. It is at the base of a limestone formation. The low chlorine in flowing wells was again shown in sample No. 319, which was taken from a well 325 feet deep,—in sand, clay and gravel, 230 feet; rock, ninety feet. The location is in a valley, one-half mile from the above spring. and one and one-half miles from the well represented by No. 309, which also yielded .312 chlorine.

Three other fairly deep valley wells yielded .312 chlorine, but these did not penetrate to the flowing stratum (Nos. 320 to 322). No. 323, taken from a small creek in Storey Valley, also yielding .312 chlorine. Approaching Houston, the flowing wells again

yielded the high salts. No. 324 represents a well 250 feet deep, located in Storey Valley, about three miles northeast of Houston, and yields 6.76 parts chlorine. A mile further the highest natural chlorine of the county was met in a well 300 feet (?) deep, which gave a yield of 22.67 parts. This well was far removed from any habitation. A much lower datum (1.87 chlorine) was given by No. 326, which was from a well drilled some 250 feet deep, according to statement. No. 327 was from a drilled well 200 feet deep, giving .312 chlorine. The depth of the well represented by No. 328 is not known. No. 329 was taken from a flowing well, 208 feet deep, in eleven feet of soil and 197 of rock, located one and three-fourths miles east of Houston (chlorine, 15.0). No. 330 was from a flowing well, 241 feet deep, located one and one-fourth miles northeast of Houston (soil, 40; sandstone, 201), indicating a dip to the northeast from Houston. This corresponds to previous data showing a dip to the north.

Later in the season a few samples of flowing wells between Hokah and La Crescent were secured. They are between 200 and 300 feet deep in clay, sand and rock, and in one case limestone was given (No. 482). They are all in the valley of the Root river, and yield a uniform chlorine of .312 parts (Nos. 481 to 485).

Two samples were taken at La Crosse, to check over. They are from a flowing well, 500 feet deep, the city supply, and a non-flowing artesian well, 500 to 600 feet deep. Both yielded .936 parts chlorine, which is a trifle higher than the deep Hokah sample. They also reach the granite, and are presumably from the same, or a similar, vein of water.

Having thus delimited the chlorine in available waters both east and west, as well as north, of Houston, we made one trip to the southwest and another to the south by southeast.

On the Yucatan Valley road, the first sample (No. 331) was taken three miles southwest of Houston. Its chlorine (1.82) was rather low for a flowing well, 316 feet deep. The rock data were not known, and possibly the depth was overstated.

One-fourth mile from the well represented by No. 331 is another flowing artesian, ninety feet in sand and gravel and 140 feet in rock (No. 332). Its chlorine (11.44) corresponds more to the deeper Houston wells. One and one-half miles further on a drilled well, in seventy-five feet of sand and gravel and thirty-five feet of rock (represented by No. 333), gave chlorine, 1.95.

Five and one-half miles southwest of Houston, another com-

paratively low chlorine (1.24) was obtained from a well 360 feet deep, and a still lower one (.728) from its neighbor, half a mile further southwest (Nos. 334-335). These would indicate a diminishing chlorine in the southwest, also; but this suggestion was contradicted by a flowing well seven and one-half miles further on, which yielded 3.25 parts, and was, moreover, the last available flowing well in that direction. Its water came up from a depth of 390 feet (No. 336). Samples Nos. 337-338 were taken from springs eight and eight and one-half miles southwest of Houston. No. 339 was taken from a drilled well (in clay, ten feet; sand, eighty-six feet; and rock, four feet), located at the general store at Yucatan.

Climbing the high ridges, samples from two deep wells were obtained on the return to Houston. No. 340 was from a well driven through sixteen feet of clay and drilled through 322 feet of solid rock. No. 341 was from a well two and one-half miles from Yucatan and one-half mile north of the well represented by No. 340. It passes through a similar quantity of rock. Both of these wells yield a low chlorine, No. 340 giving the ridge normal (see No. 312), as obtained north and northwest of Houston.

A final trip was made from Houston, south to Sheldon, and then east over the ridges, three miles, with a return on the Badger's Spring road, north by northwest, to Houston again. No. 348 was from a drilled non-flowing well, some 380 feet deep, and located about 100 feet on the up slope of the sandstone hill one and one-half miles southeast of Houston. No data were given, but evidently it must chiefly pass through solid rock (chlorine, 4.16). It is apparently from the same stratum of water as the more shallow Houston artesians. No. 349 was taken from a well one-fourth mile further south of No. 348. It was given as about 100 feet deep, but that may not be correct, as it is on practically the same level as No. 348 (chlorine, 3.12). This well passes through some clay before it reaches the rock. No. 350 was from a flowing valley well, one-fourth mile south of No. 349, and drilled to 380 feet. Its chlorine (3.72) is intermediate between Nos. 348 and 349. Nos. 351-352 are of especial interest, as demonstrating the theory of two distinct strata of water, under pressure, and differing in the quantity of sodium chloride. No. 351 was taken from a flowing well, from a depth of 275 feet, in 100 feet of soil and 175 feet of rock, located in a small valley two and one-half miles south by southeast of Houston. Its chlorine is low (.65), and the flow decreasing. Possibly quantity of water and quantity of chlorine are corollaries.

The neighboring well (No. 352), one-fourth mile across the field, also flows, but at a depth of 400 feet, and with about six times the amount of chlorine (3.64). The owner, Mr. Andrew Lee, stated that a good flow was struck at 300 feet, but by reason of the contract to force water into the house, another 100 feet was drilled, and the second larger flow, which now supplies the farm, was obtained. Undoubtedly No. 351 comes from this earlier flow mentioned by Mr. Lee, as the correspondence in depth is the same between his first flow and No. 351; and moreover, the chemical data of the two at present neighboring wells are so decidedly different. This is further borne out by the wells in Houston village. Nos. 353-355 were taken from drilled valley wells, but generally located on small eminences. The wells represented by No. 353 is entirely in hardpan clay, just touching the rock. The well represented by No. 354 passes through clay and rock. The well represented by No. 355 is on a small rock outcrop (chlorine, .39). No. 356 was taken from a flowing well, between 372 and 392 feet in depth. No stratification data were given. It is located in a valley, some five miles southeast of Houston (chlorine, .416). Nos. 357-358 represent wells that are driven in sand and clay, located on small elevations, six and seven miles southeast of Houston. No. 359 was from a dug well in Sheldon.

It will be noticed that the high chlorine does not extend as far south as the well represented by No. 356, which, although of considerable depth and located in the valley, yet gives but .416 parts. No other flowing well samples could be obtained in this district. The drilled wells here also give the .312 datum, as does the dug well at Sheldon.

On the return from Sheldon, over the east ridge road, No. 360 was taken from a tank, after three days' standing, and must be disregarded. No. 361 was from a well of similar depth located one-half mile east of the well represented by No. 350. It passes through clay, sand and rock. Another sample of a similar well, taken one and one-half miles east of the well represented by No. 361, passes through clay, twenty-four feet; gravel, twenty-four feet; limestone, 200 feet; and sandstone, sixty-two feet. These ridge wells gave the usual ridge chlorine (.312), as also do the large "Badger Springs," which well out at the foot of a rocky, uninhabited bluff, three miles east of Sheldon (No. 363).

But two samples were taken on the return trip. They were both from comparatively shallow wells, and gave the lowest chlorine

in the county (.208). No. 364 was from a dug well in clay, some four miles southeast of Houston, and No. 365 was from a drilled well in clay and gravel, 120 feet; granite, two feet; and slate, twenty-eight feet. The data for the well represented by No. 365 were given by Mr. Saunders, the owner. It thus appears that, in the present wells, a high chlorine prevails throughout Houston village, and extends a few miles in all directions, as evidenced by the flowing and a few common drilled wells. The chlorine probably comes from saltiferous strata of either the Potsdam sandstone or the cretaceous formations. It will be necessary to study the geological stratification as well as the geographical location of new wells for analysis. More complete study of the state will materially assist in determining what is the nature of the salt-carrying formations.

In the southern half of Houston county samples from but few flowing wells were obtained, and most of the apparently good waters yielded from .208 to .312 parts chlorine per 100,000 (Nos. 450-480). The Spring Grove town wells yielded 4.00 parts chlorine, but these are considered suspicious waters. No. 476 represents an apparently natural water at 300 feet, yielding 1.0 part. It passes through twenty-five feet of soil and 275 feet of rock. In the town of Caledonia the trace of the chlorine is shown in the municipal supply,—a well 300 feet deep, with a chlorine of 1.3 parts, and an otherwise analysis evidencing organic purity (Lab. Anal., No. 499). The presence of nitrates, however, may account for at least a part, if not all, of the salt.

Two other wells of especial interest were taken in Houston county. The great "Madcap," near Brownsville, gave .7 parts of chlorine (No. 457). This well is 600 feet deep, and its general analysis is good (Lab. Anal., No. 485). Southwest of the "Madcap" another fine flowing well was sampled, at Freeburg. This one is 650 feet deep, and passes through clay, eight feet; sand, thirty-eight feet; sandstone, ——; and red ochre, —— (Mr. J. R. Graf, owner). The chlorine of this well is practically the same as the Caledonia town supply. Its sanitary analysis is also very good (Lab. Anal., No. 484).

Theories based on two or three analyses are scarcely tenable, but these flowing wells, taken in conjunction with the Hokah and La Crosse municipal supplies, seem to indicate a general deep water chlorine of about one part for eastern Houston county, and probably for the whole county outside the Houston district. We

have, however, no conclusive proof that the salt district of Houston does not extend southward, and the deep wells of the future may reveal it.

At present we may be sure of its extension from Houston south about three miles, towards Sheldon, east to the vicinity of Mound Prairie, north to within about two miles of Money Creek village, west about five miles to the vicinity of Money Creek station, and southwest about seven and one-half miles to the vicinity of Yucatan. Over the rest of the county no prevailing high chlorine was found, save in the four deep wells previously mentioned. The common wells range from .208 to .312 parts chlorine per 100,000.

A trip along the Mississippi bank, from La Crescent to La Moille, yielded no sample of importance, as there is not a single deep well along the valley road. At Winona, however, the (Houston?) chlorine again manifested itself. A flowing artesian well yields a part of the city supply (No. 380). This has been given a depth running from 495 to 500 feet, and up to 1,300 feet. Presumably, the first or second figures are correct. The city engineer could give no data as to the stratification, but it is presumably river debris and sandstone to the granite, which at this point is some 500 feet below the surface.

The salt datum was about what we found in the more shallow Houston chlorine district (7.28 parts). The laboratory analysis was good (No. 482). No other wells were obtainable in Winona proper. In the suburb of Sugar Loaf, which lies just across the valley of Lake Winona, three flowing and one formerly flowing well samples were secured (Nos. 406-409). These range from 285 to 365 feet in depth, and show a very low chlorine (.208 to .416).

The strata for the first two were given by Mr. Anding, as follows:

Black sand loam and muck (river debris)...	65 feet
Shale sandstone..........................	50 feet
White sandstone (water flows)............	25 feet
Blue sandstone...........................	142 feet
White sandstone (water flow heavy).......	40 feet

Small layers of slate and quartz appear among the larger formations.

The data of the wells represented by Nos. 408 and 409 were given as eighty feet of sand and 237 feet of rock. Mr. W. P. Hammond, owner of the well represented by No. 409, states that in time of local flood and high water in the Mississippi the water

level in his well is so elevated as occasionally to flow. Within a few days, however, of the decrease of the river, the water in the well also drops back again. This would go to show that the source of much of the water in these wells is local. They are evidently too shallow to touch the salt-carrying flows which supply the city.

Three miles west of Winona a flowing well 460 feet deep, in gravel, sandstone and granite, again yielded the salt corresponding to the deeper Houston wells (15.6), and its neighbor, a well 360 feet deep, with unknown strata, gave the lower or more shallow Houston chlorine (8.58).

No other natural high chlorines were obtained in the vicinity of Winona. A long trip was made into the heart of Winona county and within but a short distance of Money Creek village, but in the absence of deep valley wells nothing can be affirmed as to the possible chlorine, save in shallow valley and deep ridge wells, when it runs from .208 to .312 (Nos. 486-503). Presumably, however, a deep flowing well between Houston and Winona would yield a high chlorine. North of Minnesota City no deep valley wells of any description were known of until we reached Lake City. Here the old railroad flowing well had been closed with a plug because of the salty nature of the water. This plug was removed, and after flowing three hours a sample was taken. Analysis gave the remarkably high figure of 140.0 parts. The well is 820 feet deep, passing through:

River deposit,	207
Sand and Shale,	93
Sandstone,	520
Total depth,	820 feet.

This brings the bottom of the well 115 feet below the level of the sea, as Lake City has an elevation of 705 feet.

The surface and common dug wells of Wabasha county yielded (Nos. 504-542). Some work, however, yet remains to be done in a chlorine of .25 to .28, judging from the few good samples taken in northwestern Wabasha county. The samples Nos. 543-568 were taken in southern Wabasha, northern Winona and northeastern Olmstead counties, with Plainview as a center, and yielded practically the same figures, save that in four cases there was a drop to .19 parts (Nos. 552, 557, 558 and 559). This would indicate a diminishing normal for the second tier of counties. However, the

lowest chlorines, taken at St. Charles, Dover, Eyota, Byron, Kasson and Rochester (Nos. 413-440 and 444), yielded .208 parts. This was given in but eight samples out of the twenty-nine taken, yet it indicates an accordance with the counties to the south.

In the vicinity of Dodge Center and on the Mantorville road nine samples were collected, two of which showed .180 (Nos. 599-602) and a third .142 (No. 603). This latter (.142) is the prevailing figure for Dodge, Steele and Waseca counties, including the Waseca water supply from a well 1,187 feet deep, and it likewise appears in places in Blue Earth county (Nos. 569-634, 658 and 660), and again in Madelia, Watonwan county (Nos. 790-795). Throughout the second tier west, and as far north as we have gone, this figure appears at various points, aside from those mentioned. Thus we find it in Cottonwood county, sixteen miles north of Windom, in Bastin's flowing well, twenty-five feet deep (No. 684); in Murray county, in Lake Siegal, two miles south of Tracy, and in Lyon county, eight miles southwest of Marshall (Nos. 756-758).

Fifteen specimens of springs, wells and lakes, widely scattered, from Winona to Pipestone and north to Chippewa county, yield .19 parts chlorine. These are from the White Water river, at Elba, Winona county (No. 552); a drilled well, 290 feet deep, near Plainview, Wabasha county (No. 557); a spring (No. 599) and a flowing well (No. 602) near Dodge Center, Dodge county; a well (No. 595) in Blooming Prairie, near Steele county; a drilled well, 180 feet deep, near Elysian, Le Sueur county (No. 633); a spring (No. 701) and two wells (Nos. 703 and 704) near Slayton, Murray county; two springs near Lake Benton, Lincoln county (Nos. 725 and 727); a flowing well, sixty feet deep, near Tracy, Lyon county (No. 738); two springs near Canby, Yellow Medicine county (Nos. 824 and 830). The Chippewa river, at Montivedeo, Chippewa county, also yields .19 parts chlorine, but that river is contaminated, and its normal is probably less (.142?).

The lowest chlorines in the state thus far obtained were from (1) Wm. Iver's flowing well, four miles north of New Richland, Waseca county (No. 615); (2) Rice spring, seven and one-half miles southwest of Tracy, and consequently in Murray county (No. 734); (3) Lake Shetek, likewise in Murray county (No. 734); and (4) Fish lake, four miles southeast of Windom, Cottonwood county. These four widely separated samples gave .095 parts of chlorine. They are so few in number that they cannot be taken as typical data for these districts. Moreover, a number of excellent flowing wells in the vicinity of Mapleton gave a yield as high as .38 to .52 parts

(Nos. 639-656), and the deep flowing wells and springs of Mankato all gave .57 (Nos. 778-783). Some more work along these counties will be required before we can draw an isochlor map. At present we should consider that, outside the flowing wells in the vicinity of Mapleton and Mankato, the normal should range between .095 and .35 for the counties from Winona to Pipestone. Lincoln county was imperfectly worked, by reason of the poor railroad facilities available at the time of our visit. Samples from the extreme south, at Lake Benton village, and from the extreme north, taken from Canby, gave .19 to .28 parts, respectively. As to the rest of the county, we do not know.

From Winona to Tracy there was but a single well which, from its data, depth and environment, suggested a high natural chlorine. That one was the Minneopa drilling, where operators went down 1,000 feet for oil, but instead of oil obtained a fine stream of water. It has yielded a steady flow for the twelve years since its beginning.

Its analysis shows 27.55 parts of chlorine. This well is not as deep as the Waseca supply in the next county, and moreover, according to the statements both of the village engineer and the geological survey, the water comes from a depth of but 575 feet. This is the more interesting, since some of the Mankato deep wells, a few miles northeast, are drilled to 666 feet, yet give low chlorines (.57 parts), and the Lake Crystal well, drilled to 735 feet, including thirty-five feet of granite, gave but .475.

These data may possibly play an important part in an isochlor map for the state. The geological data were given in a report by counties.

In Lyon county a new high chlorine district was encountered. This is an extensive area, as we have traced it from the town of Tracy northeast as far as the Minnesota river. It was not in evidence at Canby, Yellow Medicine county, but we were able to follow it along the St. Louis road into Lac qui Parle county and up to the Dakota border. How far north and northeast and east this district may extend is a matter of conjecture.

Good authority has told us of "salt licks" and small salt lakes in southeast Chippewa and southwest Kandiyohi county, possibly surface waters corresponding to what we found near Marietta, in Lac qui Parle county, and moreover, a recent analysis sent to the geological survey gave a high salt in the deep well at Glencoe, McLeod county. In addition there is the well known salt district centering in Belle Plaine, Scott county. (See Nos 785-789).

Tracy is supplied by an artesian well, 724 feet deep. (For the

stratification, see report by counties.) This well, which penetrates the granite, yields a chlorine of 1.52 parts, and marks the boundary of the new district as known at present. No similar wells were met from Tracy northwest until within four miles of Marshall, where a chlorine of 4.75 was found, in a flowing well, 400 feet deep.

Centering in Marshall, we studied the district as far as the available waters permitted us. The present village supply is from a flowing well, 396 feet deep. (For its stratification, and that of the wells 248 feet deep mentioned later, see report by counties.) The chlorine of these wells runs to 3.23. The new flowing well, 248 feet deep, is of much softer water. It yields a much higher chlorine (15.6), and moreover yields a small trace of nitrites. The presence of nitrites is considered suspicious even in deep waters, but the study of a large number of similar wells yielded almost uniformly the same results. (See Nos. 744-747, 759-763 and 774.) This pertains, however, almost entirely, to the wells 248 feet deep in the neighborhood of Marshall, and may be possibly a resultant of peat decay. Moreover, the free ammonia in both these village wells is excessive (Lab. Anal., Nos. 491 and 492). Other ammonias were not taken.

From Tracy, flowing wells had been sampled six and eight miles northwest, with low chlorines (Nos. 738-739). These, however, were but sixty and 130 feet deep. Four miles to the southeast (i. e., towards Tracy) three high chlorines were obtained, two of the deeper, one of the more shallow variety (Nos. 746-748, chlorines, 5.22, 10.92 and 4.75).

No. 749 represents one of the wells, 400 feet deep, one and one-half miles south, and No. 750 represents a well, 250 feet deep, nearer town (chlorines, 3.22 and 13.77). Nos. 751-752 were taken from wells in Marshall (chlorines, 3.8 and 4.03). No. 753 represents a shallow well, evidently contaminated.

Going west from Marshall the chlorine diminished, as shown by the 225-foot flowing well, 225 feet deep, taken six and one-half miles west of Marshall (No. 754; chlorine, 1.42); likewise, and more pronouncedly, by a flowing well of unknown depth seven and one-half miles southwest of Marshall (No. 756; chlorine, .142). The spring samples also gave low chlorines (Nos. 755, 757-758).

Towards the north and east of Marshall the chlorine still prevailed, and appeared to increase. Some of the samples, however, were from common drilled wells, in yellow clay and hardpan, and their salt may be, probably is, both natural and urinal.

The persistence of enormous chlorine in a number of wells may

be taken to evidence a high natural chlorine. Moreover we cannot condemn on the ground of nitrites, because the soil in this vicinity probably carries these salts. From Marshall we went as far north as Cottonwood, and in the village well found the highest chlorine of the district thus far studied (No. 771; chlorine, 77.9). From Marshall we went northwest to Canby. The country about gave no high chlorine, save that of evident contamination, for several miles west and south. Ten miles east chlorine was met in a large flowing well, 173 feet deep, in blue clay and hardpan (No. 839). Its yield (89.2) was greater even than the Cottonwood well. Again, a smaller but still high chlorine was found one mile north of St. Leo, in a well, 205 feet deep, passing through clay and twelve feet of "black stone" (No. 840; chlorine, 12.8). East and southeast of St. Leo the wells were comparatively shallow until the one represented by No. 834 was reached. This was located in section 12, Berton township, fifteen miles southeast of Canby. It is drilled to 210 feet in loam, two feet in clay and soapstone, 115 feet in red rock (supposed to be pipestone), and in quartzite (?) 130 feet. The chlorine (66.2 parts) is very high, and so also are the nitrous and nitric acids. No other well worth taking was seen until we reached a point twenty-four miles east by southeast of Canby, and secured a sample from one 175 feet deep (No. 845), very similar in analysis to No. .844 (chlorine, 81.5). The scarcity of deep wells in this district renders the delimitation of chlorine extremely difficult.

In and about Granite Falls and Montevideo there were no wells of much depth, and no high chlorines save those of contamination. The Hanley Falls town well, however, gave a 20.4 chlorine in a well 250 feet deep (No. 865). At Wood Lake the well is 160 feet deep, and gave chlorine 4.1 parts (No. 866). The shallow wells in the vicinity of Echo gave from .095 up.

The country in east Yellow Medicine county was but imperfectly worked. This was due to a lack of deep wells. However, the preponderance of evidence is in favor of high chlorine for that district. In the immediate vicinity of Dawson, Lac qui Parle county, the wells are mostly of little depth, and many are contaminated. A surface chlorine of .142 was the lowest figure obtained, but the small number of available good samples could scarcely establish any positive normal. Presumably from .142 to .35 parts chlorine covers this area.

Ten miles southeast of Dawson, at 129 feet, the chlorine was .76, in good environment. Four miles east of Dawson, at 242 feet, the chlorine rose to 1.5 (No. 808). Six miles northeast of Dawson

a depth of 185 feet gave .47, and 235 feet gave 1.04 parts chlorine (Nos. 889 and 890). Five and one-half miles north a well 240 feet deep gave 6.6 parts chlorine (No. 891). Two and one-half miles to the northwest of Dawson, at 185 feet, the chlorine was .66. Four miles northwest, at 228 feet, the chlorine was 1.1, and seven miles northwest it had jumped to 49.4, at a depth of 254 feet (No. 895). This well was the first of the series to reach the rock (granite?). In the western part of Lac qui Parle county all the wells taken yielded high chlorine whether deep or shallow. Some, of course, must be thrown out by reason of contamination.

The underlying strata in west Lac qui Parle was given by local well drillers as:

Loam, 2 feet,
Yellow clay, 20 to 30 feet,
Blue clay, 50 to 100 feet,
"Sea mud," varying deposits,
Granite.

The sea mud is described as fine white to gray mud, with a decidedly salty taste (L. M. Mayland, driller). This substance may be that fine, kaolin-like resultant of the long-continued disintegration of those ancient rocks which were exposed in Minnesota for ages before the cretaceous ocean. It apparently overlies the granite or pre-cretaceous rock, and may be the source of this western salt. At all events, it is worth noting for future reference. Mr. Mayland has promised to send us the next specimen he secures.

Four miles north of Madison a well, 400 feet deep, yielded 74.5 parts of chlorine. Its strata were unknown, but it probably reaches the granite (No. 897). No. 898 was from a well with dirty environment. Six miles northeast of Madison a datum of 5.7 was obtained from a well 180 feet deep, in good location (No. 899). No more deep wells were available.

In Madison proper the high school well is 313 feet in the drift, to the granite, passing much "sea mud." The location is good, and chlorine 76.0. Nos. 901 and 905 were from tubular wells in the village. The chlorine is uncertain. Four miles southwest of Marietta, Lac qui Parle county, the first surface high chlorine in uncontaminated waters was found in a small lake which would have been passed unnoticed but for its name, "Salt Lake," as it appears in a railroad "Fisherman's Guide." There is not a house of any kind within a half mile. It has no surface inlet or outlet, and is gradually drying up. There is no vegetation of any kind in the water, and back from the lake crystals of salt incrustate

the ground for fifty feet, as previously stated. It is merely a water-filled, presumably spring-fed, depression in the drift. Its chlorine (184.3 parts) is the highest in the state thus far ascertained for known organically pure waters. Wells in the Red River Valley have been found by other investigators to far exceed this figure, but that part of the state we have as yet to study.

Five miles southwest from Marietta and about one mile east from Salt Lake we found a series of flowing wells, which extends into Dakota (Nos. 909-914). They range in depth from 143 to 180 feet, and in chlorine from 3.3 to 8.5. There was but one well with this highest figure, and it was but ten feet from a barn. Excluding it, the chlorine ranges from 3.3 to 4.2. Six miles south from Marietta there is another flowing well, giving 3.3 parts. Other samples taken were more or less suspicious.

This chlorine district thus far studied may then be considered as starting at Tracy, where the city well is presumably a normal sample. From Tracy it goes northward, passing Marshall, and extending through central Yellow Medicine county, with Hanley Falls as the present known outpost, and northward through central and southern Lac qui Parle county. Further extension we cannot state as our work ceased at this point. In this district surface waters yield low chlorine (.095 to .35), but the deeper wells present varied data of high chlorine. The district thus far has been covered as carefully as the number of deep wells would permit. A few known flowing wells were practically out of our reach, but the majority have been sampled.

We wish, in closing, to say that, while an area the size of the Marshall chlorine district would, of course, be easily noted and studied, yet a number of areas the size of the Houston district might exist in the southern part of the state without our knowledge. This is especially true of the lowest tier of counties. The reason of this is evident. Our funds did not allow of many side trips, and consequently we had to limit our work to the lines of railroad. There is then ample area in any one of the counties to conceal such a small district as the one environing Houston village.

Aside from the chlorine, it will be noticed that many of the deep wells in Lac qui Parle and Yellow Medicine counties yield also nitrous and nitric acids, as well as considerable free ammonia. This leaves us under the necessity of making quantitative estimations of nitrites and nitrates, as well as chlorides, and furthermore really cuts down our reliable data to organic oxygen and organic ammonia, save in case of considerable excess of the other bodies.

All of this emphasizes the need of personal inspection, especially in case of municipal waters, in this part of the state. Such inspection is always of great value in determining the sanitary character of a water; but here it is an imperative necessity, and no legitimate opinion can be formed in any other way. Only by the most careful study of every possible source of information can a just estimate be made of these western waters.

AS TO THE NEED OF LEGISLATION WITH REFERENCE TO THE PURITY OF WATER AND ICE SUPPLIES.

The value of any piece of sanitary work is measured by the actual resultant effects secured. Any amount of demonstration and advisory suggestion is worthless without action. The present arrangement for rural sanitation in Minnesota produces at a minimum of cost a like minimum of results.

The local officer of health may be, and usually is, a physician. Often, however, the physicians refuse to serve, and this important office is given to some person with little knowledge of, and less interest in, sanitation. The community suffers.

Let us consider the most favorable conditions—where the health officer is a practicing physician. The monetary consideration attached to his office is extremely small. Fifty to a hundred dollars per annum from registration of vital statistics represents the average entire amount, and for this nominal recompense the physician is expected to care for the general sanitation of his community; expected to carry out needed reforms when the involved action often causes the displeasure of his patrons; expected to cheerfully volunteer his skilled service and valuable time at work which usually means enemies and loss of practice.

The average citizen objects to an order which closes his well; compels him to clean, disinfect and cement his outhouse; to haul away his garbage and keep his stable clean,—even though some of these may be necessary to prevent pollution of private or public drinking waters or of the village ice supply. The ice dealer likewise objects when restrained from cutting the public ice from polluted streams or lakes. He objects to orders as to the kind of material used in making his dam, which material has been found to consist in two known cases of rocks and manure.

The village council may or may not agree with the health officer as to the necessity of cleaning out filthy tanks, or the

removal of evident causes of pollution of village water and ice supplies, especially when such action would involve the expenditure of a little public money and some private energy. Persistence in the carrying out of such needed sanitary reforms is at the peril of the medical health officer's practice, and few physicians are rich enough or bold enough to face hostile local influence for the sake of the people at large, especially when said people seldom understand or appreciate the value of sanitary work.

In a word, the Minnesota rural officer of health must be endowed with the highest degree of unselfish philanthropy and with Christian charity of unusual quality, or his office is a failure. Some of the results are in evidence.

The state board of health, at considerable expense, engages men to study the natural Minnesota waters; to inspect and analyze municipal water and ice supplies; to give attention to sanitary conditions prevailing in the communities. In one village are found many shallow private wells, on the same water level with sources of pollution, and condemned also by chemical analysis. In a second, a public supply is surrounded by contaminating outhouses, cesspools, etc., and likewise condemned by chemical analysis. In a third, some stream or lake, with manure piles, outhouses, slaughterhouses, cattle yards, etc., pouring their filth into its waters, forms the ice supply. In a fourth is seen some nasty, foul smelling, open sewer, standing in a creek bed, and dignified by the name "Redwood river" or "Spring Valley creek," etc.,—a filthy, germ-breeding hothouse; a menace to the life of the community, and to the purity of water and ice supplies. Advisory suggestions are made to the local officer of health, with what results? Sometimes he is interested enough to inform the village council of the statements made, and occasionally some action is taken; but usually nothing—absolutely nothing—is done. The conditions remain the same. The doctor's practice increases; the people suffer.

Advice not reinforced by mandatory power is valueless. The responsibility should rest where there is no dependence on local conditions,—where authority is derived from the state board of health and the legislature alone. The mandatory power should be broad enough to produce results; if possible, with the co-operation of the local health officer, but if necessary for the good of the people, independently of him. The very existence of such authority would incite our local sanitarians to improve their own environing conditions, and the consequent diminished death rate would attest the great value of such action.

We would strongly suggest the advisability of securing legislation covering at least the following points:

1. Whenever a public or private water or ice supply is condemned by the state board of health, that said supply be closed at the discretion of said state board.

2. That all municipalities of the state be privileged and required to consult the state board of health as to the sanitary aspects of the location, environment and chemical analysis, of any or all, new or contemplated, sources of public water or ice supply.

3. That the enforcement of the above provisions be secured by a fine.

4. That a small appropriation be asked for to cover railroad fare and subsistence when on trips made in accordance with said provisions.

Very respectfully submitted,
HUBERT CAREL.

REPORT OF THE DIRECTOR

OF THE

VETERINARY DEPARTMENT.

1899-1900.

MARCH 31, 1899.

The work in the veterinary department during the last quarter has been of the usual routine character, in addition to a considerable number of peculiar experiences in the way of violation of rules and laws, and serious outbreaks of diseases that are not well understood. I would take pleasure in reporting many of these, but the limits of a reasonable paper forbid more than a very few. We have several times had cause for complaint against local health officers. One case that deserves mention is that of James Powers, ex-chairman of Mounds View township, Ramsey county, who repeatedly neglected or refused to answer correspondence or take action as directed.

Glanders-Farcy.—During this quarter fifty-four horses have been tested with mallein. Thirteen have been killed on account of this disease, as follows: Three in Yellow Medicine county, five reported from Hennepin, one in Dakota, three in Anoka and one in Ramsey. During the past quarter twelve horses have been quarantined for re-tests, as follows: One in Anoka county, six reported for Hennepin, and five in Ramsey. Comparing the glanders-farcy situation for the past quarter with the corresponding period of 1897, we find that during the latter period 121 horses were tested with mallein and sixty-four were destroyed. Several very unpleasant instances have occurred during the past quarter in which the law dealing with infectious diseases of animals and our rules concerning glanders-farcy have probably been violated; for instance, in Echo township, Yellow Medicine county. The work in this township has extended over a long period and the file of correspondence is a very large one of about eighty-six pages, including reports. I can only give a hurried summary of the entire file in this report, but this will illustrate the point which I wish to make, viz., that our rules and regulations concerning infectious diseases of domestic animals have been repeatedly violated, and that, in some of these cases at least, we would have had weak cases had we attempted to prosecute. The following letter to Dr. Bracken gives a very complete summary of the correspondence and history of the case and is inserted here for that purpose:

Jan. 31, 1899.

Dr. H. M. Bracken, St. Paul,

Dear Doctor:—You have doubtless seen my correspondence with Mr. P. S. Oie, C. B. S. of Echo township, Yellow Medicine county, concerning the matter of glanders among horses belonging to Mr. Julius Miller. You will also remember that Dr. Brimhall called to talk this matter over with you during my recent illness. The essential facts in the case are as follows:

Julius Miller of Echo township, Yellow Medicine county, owned three horses which had been in contact with horses belonging in a stable where glanders undoubtedly existed. One of Mr. Miller's horses was considered suspicious by Dr. Lambrechts, who was at that time testing a number of other horses in the neighborhood. The board of township supervisors decided to have Mr. Miller's horses tested. I understand that Mr. Miller's horses were not quarantined at the time they began taking the first temperatures. No objection was made to taking the preliminary temperatures, but when the chairman and Dr. Lambrechts went back to make the mallein injection the owner had a crowd of neighbors on hand who were boisterous and inclined to make trouble. One of these neighbors went to the chairman and had some conversation with him which indicated that he, the neighbor, was opposed to the work they were doing. They, however, continued to prepare for the test until Mr. Miller appeared at the barn and in an excited manner objected to making the test. Neither the chairman nor Dr. Lambrechts were able to understand German, the language used by Mr. Miller, but one of the other members of the board, who could understand German, explained to them that he was saying that he would not have the horses tested, and if they made the test they would have to do it over his dead body, or something to that effect. The chairman and Dr. Lambrechts thought it was unwise to continue the test under such circumstances, and left after placing the horses under quarantine. A few days after the chairman was informed that Mr. Miller's horses had been stolen in the night. Inquiry in the neighborhood gave him no light upon the manner of their disappearance. Mr. Miller insists that the horses were stolen and that he knows nothing about them. There have been about twenty horses killed recently for glanders in this neighborhood, a great many others tested and inspected, and Mr. Miller is the only owner who has made serious objection or interfered in any way with the work. The chairman, Mr. Oie, has proven himself a very efficient officer and deserves to be upheld and encouraged in his work.

On January 18 Dr. Brimhall visited Echo township and investigated the situation as thoroughly as possible, but was unable to learn anything further concerning the disappearance of the horses. Public sentiment in the township unanimously demands that this man be punished, and if there is reasonable grounds for a case I earnestly hope that something of this kind may be done.

I do not know that there is anything in the general health laws which provides that persons resisting local health officers shall be guilty of a misdemeanor, etc., but I presume there is. It may be that a case of this kind could be based upon the law dealing with infectious diseases of animals, but you, of course, will be a better judge of that. Permit me to suggest that if there is no provision in our law which makes such resistance a misdemeanor,

that we should incorporate it in the amendment to be asked for this winter. I should like to see it put in the law dealing with infectious diseases of domestic animals if anything more explicit on this point is needed.

I send you the Echo township file and am anxious to make the veterinary department as helpful as possible in any of these cases which you may decide to prosecute.

Very respectfully,

M. H. REYNOLDS.

Dr. Bracken's letter of February 8, explains why legal action was not taken:

Dr. M. H. Reynolds, Director Veterinary Department, State Board of Health,
St. Anthony Park, Minn.,

My Dear Doctor: Your letter of Jan. 31, relating to Mr. Miller of Echo township, Yellow Medicine county, and his horses, was referred to Mr. Richardson, and to-day I have his answer to the effect that we can do nothing looking to the punishment of Mr. Miller. The burden of proof would rest upon the local or state board of health in connection with the disappearance of the horses.

Boards of health have police power in dealing with infectious diseases of animals as well as of man. Those who were making the test should not have allowed Mr. Miller to bluff them. Had he interfered in any way with their proceedings they could have had him arrested.

The thing for the local board to do is to carry out a little detective work, and if they find any of the horses to quarantine them and start over.

I have written to Mr. Oie as per inclosed copy.

Respectfully,

H. M. BRACKEN,
Secretary.

The interesting question now remains open as to how much and what police authority a local health officer, or Dr. Brimhall or I for instance, have in dealing with cases of this kind.

Another case.—Six horses and two mules belonging to Anton Hillemeire of Kingman township, Renville county, were tested by Dr. Brimhall on March 17 and 18, 1898. Two mules and one horse were condemned and killed on clinical symptoms, two others gave reactions but showed no clinical symptoms and were quarantined for re-test. Mr. Donnelly, chairman of the town board, was informed concerning the matter on the 17th, but did not even visit the Hillemeire farm or pay any attention to the matter at the time. On the contrary he went to another town thirty miles away. Dr. Brimhall reported that Mr. Donnelly had been a school teacher, was quite an intelligent man and undoubtedly knew his duty. We had considerable correspondence between

Mr. Kenning, Mr. Donnelly, Dr. Bracken and myself over this incident, but nothing came of it beyond a suggestion from Dr. Bracken to Mr. Kenning that he take legal action against Mr. Donnelly.

It should be remembered in this connection that our rules permit local health officers to quarantine certain cases for re-test, the quarantine period to be not shorter than thirty days nor longer than one year. The file of correspondence dealing with this case is a large one and I will summarize the remainder by saying that there is good reason to suppose that Mr. Hillemeire has persistently violated quarantine so far as these two horses were concerned. Under date of January 23 I wrote Mr. Donnelly that I had information to the effect that Mr. Hillemeire was paying but little attention to quarantine regulations, and he was evidently unable to appreciate the consideration that the state and town boards had shown him. I suggested that re-test should be made at once, and that in the meantime it was his duty as local health officer to see that quarantine regulations were obeyed. However, as the year did not expire until the middle of March, I did not feel like forcing the issue. In the latter part of February I received a rather astonishing letter from an attorney of Olivia. This was to the effect that Mr. Donnelly, chairman of Kingman township, had requested him to write me concerning the Hillemeire horses. He stated that Mr. Hillemeire was very anxious to have his horses tested at once, and asked me to authorize him to employ a veterinarian and have the horses examined at once and thus settle the matter. This, after a great deal of correspondence concerning the case and some time after I had sent mallein to Mr. Kenning for the purpose, and had urged Mr. Donnelly to employ a veterinarian and have the horses tested soon. Early in March I received a letter from Dr. Butters, veterinarian at Renville, asking for sufficient mallein to test the two Hillemeire horses, and stating that the town board was making arrangement to have these horses tested. A few days later I received records of test showing that both the horses had given marked reactions, but still showed no clinical symptoms. I was also informed by Dr. Butters that the town board was desirous of having the remaining four horses tested, and the necessary mallein was sent him for the purpose. After waiting a reasonable time for report of the test, I wrote Dr. Butters again, and was informed that during this interval an election had occurred and the old town board had been displaced. I wrote at once, asking for the name of the

new chairman and received a reply under date of April 3, giving the desired information. Dr. Butters wrote promptly to the new town board concerning the matter, and urged that the work be completed, but they have taken no action at last account. I have now written the new chairman and will endeavor to have the remaining horses tested at once.

I have received several letters from Mr. Kenning, a very good friend of the state board of health, urging that the state board take legal action against the offenders in this case. There has been some unpleasant feeling among the better class of farmers in this township, and both the state and local boards of health have been severely criticised by them. Here is an outbreak of glanders involving an immense amount of correspondence covering a period of more than a year. The local authorities have been very negligent, utterly ignoring the serious situation at the beginning, and afterwards making no effort to enforce quarantine; and yet the horses were re-tested within the prescribed time of one year from the date of the first test. The owner has evidently violated quarantine repeatedly. Mr. Kenning, representing the state board of health, informed both the chairman and the owner concerning their duty in this case and his suggestions were ignored.

A somewhat different case has recently arisen in Mounds View township, Ramsey county. Both the owner of the horse and a farmer who was keeping the horse for him were informed about four weeks ago by a veterinarian that one of the horses was affected with glanders. Neither party paid any attention to this information, and recently the owner made arrangements to sell the two horses, one of them, the horse in question, to a gentleman from Minneapolis, who was informed that the horse was suffering from distemper; and not being a practical horseman agreed to buy the team, making a payment of $20.00 to bind the bargain. The intending purchaser became suspicious and had another veterinarian examine the horse, who diagnosed a marked case of glanders. In this case we have a farmer, a horse dealer and a veterinarian, all of whom had knowledge of, or reason to suspect, the existence of glanders in this horse, and yet none of them reported to either the local or state board of health. The glandered horse has since been killed and the stable is under quarantine, pending mallein test of the remaining horses. This has also been reported to Dr. Bracken and will doubtless be given a fuller description in his report as executive officer.

Hog Cholera—As was expected, the hog cholera situation has been very quiet. But seven townships in six counties have been reported. It must not be taken from this that hog cholera has practically disappeared. There is every reason to expect serious trouble from this disease during the late summer and fall months. Comparing with the first quarter of '98, we find that twenty-eight townships in sixteen counties were reported during the latter period.

It will undoubtedly be necessary to continue, during 1899, our regulations concerning railroad shipping pens. I am satisfied that the movement of feeding and breeding stock from these points into the farming districts has been the cause of many outbreaks and severe losses. Our regulations already prohibit importation of hogs not intended for immediate slaughter or for exhibition at state fairs, unless they come crated, shipped in other than stock cars and accompanied by a certificate stating that they were free from the disease when shipped, and that there had been no hog cholera in the neighborhood from which they were shipped for a period of at least six months previous to shipment. This certificate is to be signed by a licensed veterinarian, physician or health officer, and delivered to the local health officer of the district to which they are shipped. Our regulations prescribe that hogs which have once entered railroad shipping pens can be taken out for but one purpose, viz., immediate shipment by rail to some point for slaughter. If these regulations can be enforced they must certainly prove a great help to us in the struggle that will come during 1899, but I fear they are not as fully enforced as they should be, and we must watch this matter more closely in the future.

PLANS FOR THE COMING SEASON.

I would respectfully submit the following plans and suggestions for work with hog cholera during the coming season. First, the employment of a second field veterinarian to do work similar to that done last year by Dr. Annand, providing, of course, that our funds will permit such action. This work should continue through a similar period, and will probably cost about the same amount, viz., $165.00 to $180.00 per month for five months. I think it would be well for this work to be done in about the same number of townships as last year, but in a line across the state south of those in which Dr. Annand worked last year. In view

of the fact that during the entire hog cholera season of 1898, the disease appeared in but nine townships in or north of the territory visited by Dr. Annand, and in view of the very satisfactory way in which these outbreaks were handled, I am encouraged to believe that the infected area can be gradually reduced by building wall after wall of this kind across the state, each one south of the preceding; in other words, to gradually force the disease southward towards the Iowa border.

The work with glanders and diseases other than hog cholera will probably be such during the coming summer and fall that Dr. Brimhall will be able to pay but little attention to the latter disease, and we must therefore depend on other help for most of the field work in this line. It is earnestly hoped that the present legislature may give us an increase in the annual appropriation for dealing with infectious diseases among domestic animals, and if this is done our plans can be quite materially enlarged. Prominent stockmen of the state have taken quite an interest in this matter, and it is pleasant to learn that we have such support, whether the legislature sees fit to grant the appropriation or not.

I have no reason to believe that we have made a mistake in releasing quarantine under certain conditions, so as to permit the sale of healthy hogs from quarantined farms. Such permission has been granted quite a number of times in cases where there had been no appearances of the disease during a period of several months, and when present stock was in condition for market, and upon written recommendation from the local health officer that such action be taken.

Tuberculosis—I take special pleasure in reporting that the various state institutions are slowly coming into line in the matter of tuberculosis in dairy herds. The following letter was recently received from Dr. Rogers of the Minnesota School for the Feeble-Minded at Faribault:

March 20, 1899.

Dr. M. H. Reynolds, St. Anthony Park, Minn.,

Dear Doctor: When can you make an appointment for the examination of our herd with reference to tuberculosis? Dr. Wilson suggested while here the other day that you might also desire to investigate the epidemic among our hogs. We are losing quite a number each month. The farmer describes the symptoms as first a cough and stiffness in the back, followed by an inability to use their hind legs; diarrhoea soon follows. Some die within a few hours; others are sick two, three and four weeks, and occasionally some get well and appear to thrive. I would be very glad indeed if some proper investigation could be made at your convenience. Very respectfully,

A. C. ROGERS.

In response to my letter of March 28, I received another letter from Dr. Rogers, under date of March 30, to the effect that they would be ready for the test on the dates suggested and that they would have about sixty cattle to test. Dr. Brimhall left for Faribault on April 3, and at this time (April 5) he is still engaged in this work. This makes four of our state institutions which have started in earnest to have their herds tested and kept free from tuberculosis. It is difficult to understand why the other state institutions have not availed themselves of the offer which was made some time ago to do this work for them practically free of expense.

Various unpleasant features of this work have been previously mentioned. They are still making the work with tuberculosis difficult and unsatisfactory. One of these, which has been prominent during the past few months is connected with the work which is now being done by the city health department of Minneapolis outside of the city limits. The city has been conducting the tests and re-tests according to law, but the law prescribes an interval of not less than two nor more than three months before the cattle can be condemned as tuberculous. This throws a serious burden upon the chairmen of a few town boards There are a few townships near the city of Minneapolis in which the chief business of the residents is that of dairying, and there are so many herds to be tested and so much work for the chairmen that it is seriously burdensome, and to make matters worse no adequate provision is made for compensating the chairmen for this great amount of work. I have endeavored to make some satisfactory adjustment of this difficulty with the city health department of Minneapolis, but so far we have not been successful. This condition of affairs not only throws a great burden upon the chairmen of town boards, and one which they are not willing to cheerfully assume or effectually carry, but the long delay between tests affords a constant temptation to owners to violate quarantine by trading off condemned animals and then reporting that they have been slaughtered, or defiantly take them out of quarantine and sell them on the open market. To illustrate these experiences I will cite the following instances, which are only a few among quite a number of similar cases.

Early in June the city health department of Minneapolis tested cattle belonging to Alfred Johnson of St. Louis Park. One cow reacted. I wrote Mr. Moore, H. O., to the effect that I had re-

ceived such information, and told him that according to the rules of the state board of health this cow must be re-tested within three months from date of first test, and that should she react on second test, she must be killed within one month thereafter. I sent him a copy of the rules and called his attention to them. This cow was re-tested on September 12 and 13, and again reacted. I wrote Mr. Moore under date of September 23, reminding him that these cattle had been tested in June and that a cow which reacted then had reacted again on September 12 and 13. I asked him to investigate the matter and let me know what disposition, if any, had been made of this cow, but have received no reply.

Cattle belonging to J. J. Ewald of St. Louis Park, were tested September, 1898. The records indicated that one cow reacted. I wrote Mr. Moore accordingly, giving him the usual suggestions and informing him that it was his duty to see that the quarantine was enforced until the cattle were properly disposed of. This cow was re-tested December 7 and 8. I then wrote Mr. Moore that the cow had been re-tested and must be killed under inspection according to the rules of the state board of health. Not receiving any reply I again wrote Mr. Moore, essentially as follows:

February 7, 1899.

Mr. G. N. Moore, H. O., St. Louis Park, Minn.,

Dear Sir: You undoubtedly received my letter of Dec. 14 in regard to the cow belonging to J. J. Ewald. This cow had tag No. 364 in the left ear. She reacted upon second test, and should have been killed within one month from date of such test. Kindly inform me at once what has been done with this cow.

Mr. Tillbury, meat inspector of the city health department, will inspect cattle which are condemned by that department, free of expense, providing he is given due notice. Very respectfully,

M. H. REYNOLDS.

No reply has been received. Early in November last I received a report of tuberculin test of cattle belonging to Nordgren & Larson of St. Louis Park. I then wrote Mr. Moore, health officer, to the effect that these cattle had been tested. I gave him the tag numbers and description of the cattle and some suggestions concerning the rules of the state board of health and his duty in the case. Early in February I received a report from Dr. Cotton to the effect that these animals had been re-tested and that three of them reacted on second test. I wrote Mr. Moore accordingly, and suggested that these cattle must be killed within one month from date of re-test. I also suggested that he inform Mr.

Tillbury of the Minneapolis health department, and that Mr. Tillbury would then be present to inspect the cattle.

During the same month I received information from Dr. Cotton to the effect that they had tested cattle belonging to Geo. Cooley and G. H. Partridge of St. Anthony township, Hennepin county, with the following results: One described cow belonging to Geo. Cooley, and two described cows belonging to G. H. Partridge, reacted. I informed Mr. Phillips, C. B. S., that these cows must be quarantined according to the rules of the state board of health. I sent him a copy of the law and called his attention to the rules. The cows which belonged to Mr. Partridge were re-tested on February 1 and 2. These cows reacted on second test, and I then wrote Mr. Phillips to this effect and gave him instructions for dealing with the case. I asked him to attend to this matter promptly, and report as soon as the work was finished. The cow belonging to Mr. Cooley was re-tested and reacted on February 15 and 16. I wrote Mr. Phillips accordingly. Not hearing anything further from either of these health officers, and thinking that the animals might have been killed and no report made, I wrote the following letter to Dr. Cotton:

March 16, 1899.

Dr. C. E. Cotton, Minneapolis,

Dear Doctor: Can you give me any information concerning the following cattle, tested and retested in the course of your work:

Belonging to Nordgren & Larson, St. Louis Park, retested Jan. 25 and 26, 1899, one black and white cow, ear tag No. 412; black and white cow, tag No. 414; iron gray cow, ear tag No. 411. These cattle should have been killed on or before Feb. 25, 1899.

Belonging to J. Ewald, St. Louis Park, one yellow and white cow with horns, ear tag No. 364, retested Dec. 7 and 9, 1898.

Belonging to Alfred Johnson, St. Louis Park, one red cow with long horns and short tail, ear tag No. 303, retested Sept. 12 and 13, 1898.

Belonging to L. M. Cooley, St. Anthony township, one white cow, dehorned, tag No. 358, retested Feb. 15 and 16.

Belonging to G. N. Partridge, St. Anthony township, one red cow, dehorned, ear tag formerly 344, but this tag was lost and 387 substituted. One roan cow, dehorned, tag No. 354. These cattle reacted on retest Feb. 1 and 2, 1899, and I trust were properly disposed of, but I have received no notice either from the local health officer or from Mr. Tillbury.

Very respectfully,

M. H. REYNOLDS.

Dr. Cotton replied to the effect that he knew nothing further concerning the cases, that it was a matter resting between the state and town boards. I then referred my letter and Dr. Cotton's reply to Dr. Bracken.

It will be seen that I have received absolutely no information from these local health officers. I only know that the cattle have been tested and retested, and should have been destroyed. Similar cases have arisen in other townships, and the situation has become so serious as to deserve the immediate attention of this board.

Malignant Catarrh—We have had to deal with a serious but interesting case of malignant catarrh among cattle in Scott county. On the 21st of February, Mr. C. O. Hulberg, a progressive and intelligent farmer of New Market township, called at my office and asked for information concerning a strange disease among his cattle. Out of sixteen cattle five had died within a very short time and one was then sick. The symptoms as described indicated quite plainly that the disease in question was malignant catarrh. Dr. Brimhall being away from home on other work, I arranged with Drs. Bracken and Wesbrook for Drs. Annand and Wilson to visit the place for the purpose of giving the owner as much assistance as possible and also for the purpose of collecting material for laboratory study. The disease is very uniform in its diagnostic symptoms and for that reason is easily recognized, but we know practically nothing of the etiology or method of transmission, and for that reason we are almost helpless while attempting to deal with it as sanitarians. Dr. Annand gave the owner helpful suggestions in the way of disinfection and prevention, and Dr. Wilson collected material for the bacteriological examination. A number of animals have died since this visit, the total number of deaths at this time numbering thirteen. The owner has forwarded several heads to the laboratory. Dr. Brimhall made a trip to the farm on March 22d, conducted another post-mortem and collected more material for the laboratory. I have been informed that two germs have been isolated, one of which is very virulent. We are now waiting for an opportunity to conduct some inoculation experiments on cattle for the purpose of ascertaining whether the disease can be reproduced by inoculation of one or both of these germs. Dr. Wesbrook will probably report this quite fully, and I will make no further comments at this time, except to say that it is an extremely important matter. Malignant catarrh is important from an economic standpoint, particularly in the Red River Valley. Dr. Youngberg of Lake Park probably has more experience with this disease than any other veterinarian in the state, and has promised to assist us by furnishing material for laboratory work. Malignant catarrh is an old disease, but very little is known of it beyond its symptomatology and mortality. If we can demonstrate the specific origin and then learn something as to the methods of

infection and dissemination, it will be quite a triumph for the state board of health from both technical and practical standpoints.

Actinomycosis— We have had to deal with an interesting outbreak of actinomycosis among cattle in Stearns county. Two animals which showed marked symptoms of the disease were taken to Sauk Center for sale to local butchers, who refused to purchase. This came to the attention of the mayor of Sauk Center, who reported to me by telephone and asked that a veterinarian be sent to this place to take charge of the matter. The two animals in question were taken back to the farm, but there was considerable local excitement over the case, inasmuch as this man owned a large herd of cattle, numbering about 200. I wrote to the chairman of the proper township ordering quarantine of the two diseased cattle, and suggested that it would be for the best interests of the owner as well as the township at large, if the diseased cattle could be slaughtered under inspection at once. He was informed that sanitary officers now passed as fit for food certain carcasses of cattle affected with this disease, and the carcasses in this case need not be condemned unless the lesions were of such a character as to make them unfit for food. The diseased cattle were promptly killed and the carcasses destroyed because of evident unfitness for food.

Other Diseases—A strange form of influenza, which was mentioned in my last report, has appeared during the past quarter, and was probably to blame for considerable local excitement at Fertile, Polk county. The history of this case is briefly as follows: A car load of horses was brought to that place during the winter on an open car. About a week after they had arrived this disease appeared among them, the horses having been placed in a local livery stable in the meantime. Prominent symptoms were enlargement of submaxillary glands, profuse nasal discharge and anorexia. I wrote the local health officer soon after our first correspondence, and later received a telegram, which had been sent to Dr. Bracken, as follows: "Veterinarians disagree on diagnosis, disease spreading, send veterinarian tonight." In reply to this I sent a telegram and also wrote under date of March 11th to the effect that I did not think it wise to send a field veterinarian without definite information as to the nature of the trouble. A blank for reporting infectious diseases of animals was enclosed with a request that it be filled out and returned. A request was made for full information concerning the diagnoses and names of the different veterinarians who had been called into the case. The

previous history of the case and a reply from the local health officer convinced me that the disease was none other than this new form of influenza, against which it did not seem practical to make any attempt to quarantine.

Financial Matters—In view of the depleted condition of the fund for dealing with infectious diseases of domestic animals, we have been managing this work so as to spend as little money as possible during this quarter, in order that we might be able to start even with the new fiscal year. I think if the secretary makes a report of our financial condition it will be seen that this department has spent comparatively little money during this quarter.

Increased Appropriation—If the present legislature grants us an increased appropriation for dealing with infectious diseases of domestic animals, we will be in position to offer more assistance through field veterinarians and otherwise give more frequent relief to local health officers.

Our plans for dealing with hog cholera can be quite materially enlarged, but I will not go into details concerning this until the increased appropriation is assured.

The recognition which has been given the Minnesota State Board of Health by prominent men engaged in similar work in other states is very encouraging indeed. Other state boards of health are not only modeling their laboratories after ours, but they are enacting laws and establishing rules and regulations patterned after those now in use by the veterinary department of this board. The following statements are gleaned from an article recently written for the Journal of Comparative Medicine and Veterinary Archives, by Dr. Peters of the University of Nebraska, United States Experiment Station:

"Minnesota has, I believe, the most conservative law in the union in regard to this subject (infectious diseases of animals). This can be clearly shown by the way that they handle glanders and by the way they have handled their quarantine system. * * * Minnesota has given other states something to go by. * * * This question now being so vigorously taken up in Minnesota will, no doubt, be taken up in the future by other states, but it will take time for the legislators in other states to learn the lesson that they have already learned in Minnesota. * * * There are many other states that would probably take this matter up, etc., but cannot secure the support of their legislators. It is to be hoped that Minnesota will continue to give us an example in this line, and that they will not be cramped for funds, but be in position to show us what can be done in the way of quarantine and eradication of contagious diseases."

JUNE 30, 1899.

The work of the veterinary department during the second quarter of 1899 has been fairly satisfactory, except in the work of dealing with bovine tuberculosis just outside the Twin City limits, particularly near Minneapolis. This subject has been brought up for discussion in previous reports, and urgent action urged, but, so far, but little has come of our deliberations. The situation is somewhat serious, and decisive action should be taken by the board at the coming meeting in July. Further mention and discussion of the subject will come later in this report, under the head of "Tuberculosis."

Glanders-Farcy—The work with glanders-farcy during the past quarter has been very satisfactory. The state board of health rules and methods of dealing with this disease are now quite well understood by veterinarians and local health officers all over the state, and as a logical result the work is more prompt and efficient.

One hundred and twenty-three horses have been tested with mallein during this quarter. Of this number forty-five were retests. Thirty-eight horses have been killed on account of glanders-farcy. Of this number thirteen were cases that had been in quarantine previous to the present quarter, and twenty-five were horses that were tested for the first time during this quarter. Twenty-six horses tested during the present quarter are still in quarantine. During the corresponding period of 1898, 121 horses were tested and of these sixty-two were destroyed. We can never hope to rid the state absolutely of glanders-farcy, because of the peculiar nature and history of the disease. It is now quite generally accepted that there is a serious percentage of horses affected with glanders, but show no obvious symptoms of the disease, and it is even probable that such horses are occasionally infectious. A certain percentage of such horses eventually develop into typical cases of glanders-farcy, and are then quite easily recognized. The distribution of this disease during the present quarter has been as follows: Ramsey, 3; Hennepin, 5; Winona, 1; Faribault, 1; Martin, 4; Cottonwood, 1; Renville, 2; Kandiyohi, 3; Stearns, 1; Polk, 5; Marshall, 11; Nicollet, 1.

The Anton Hillemeire glanders case, mentioned in my last quarterly report, has been finally terminated. The two horses

which remained in quarantine, and concerning which there has been so much correspondence and discussion, were post-mortemed by Drs. Brimhall, Puffer, and Bolton under formal protest. The mallein test was supported by post-mortem findings in the opinion of two of these gentlemen, and this concluded our work with the case. I am informed by Mr. Kenning that the farmers living in the vicinity of this township (Kingman) are thoroughly pleased with the final adjustment of the difficulty.

You will remember that I reported at our last meeting a peculiar glanders situation in Mound's View township, Ramsey county. In this case three men,—the owner or at least the keeper, a horse trader, and a veterinarian,—were each aware that a certain horse was probably affected with glanders, but they made no report to the local or state board of health. The glandered horse was killed by my order, and the stable quarantined. This was the situation at the time of our last meeting. Since that time this farmer, Otto Peterson, has removed his quarantined horses repeatedly from the farm, contrary to conditions of quarantine; in fact Mr. Austin, chairman of the town board, has personally seen them off the farm, and warned Mr. Peterson that such action could not be permitted. But Mr. Peterson not only used these horses upon the road, but went to Minneapolis and New Brighton with them, and sold (or at least permitted his son to sell) one of these quarantined horses to a party in New Brighton, and the horse was removed to that place. On learning this fact, I wrote Mr. Wright, health officer of New Brighton, on June 7th, asking that this horse be immemdiately placed in quarantine in the stable of the present owner. On June 12th I wrote Mr. Wright ordering immediate killing of the horse in question. Under date of June 14th I received a letter from Mr. Wright to the effect that he would have the pony destroyed at once. This ends the case so far as the last owner is concerned, but does not alter the fact that this horse was taken out of quarantine and sold without permission from the state or local board of health. While we were dealing with this case Dr. Brimhall was sent to Mr. Peterson's place, with conditional instructions to kill without further delay all the remaining horses which had given positive reaction on mallein test, and which were then in quarantine. Mr. Austin, chairman of the town board, met Dr. Brimhall at the Peterson place, according to previous arrangement, and after some discussion they concluded to return to my office and urge the destruction of the horse which had been sold out of quarantine, but to give Mr. Peterson another chance and not destroy the horses remaining in quarantine. Mr. Peterson is a

poor man with a family, and if these horses were killed it would have left the family practically destitute. It did not seem absolutely necessary to inflict such hardship on the family, and the case was allowed to drop so far as the killing of the horses was concerned, with distinct instructions to Mr. Peterson that if any of the quarantined horses were subsequently found off the farm, or if quarantine was again violated in any way, the horses would be destroyed.

The Bloomer township, Marshall county, case, which was reported at a previous meeting, is now in satisfactory shape, although it seemed probable at one time that we would have very serious trouble with it. On June 6th Dr. Brimhall visited this township and tested all of the horses which according to our rules should have been tested in the first place, and that without opposition from the owners, although several had previously declared that they would resort to violence to prevent the mallein test or the destruction of any of their horses. Seven horses were killed on this trip, and seventeen have been left in quarantine for re-test. This work will now undoubtedly be closed without any ill feeling on the part of the owners, and we will have the hearty sympathy and co-operation of the neighboring farmers in future work of this kind.

Hog Cholera—The hog cholera situation is very satisfactory, and it is with great pleasure that I report a very slight prevalence of active hog cholera. The worst infected portions during 1897 and 1898 seem almost free from the disease, but we expect it to appear later in some of these old centers.

During the first quarter of 1899 reports were received from seven townships in six counties. During the first quarter of 1898, twenty-three townships in fourteen counties, and during the second quarter of 1898, seven townships in seven counties. During the second quarter of 1899, six townships in five counties.

Tuberculosis—I take great pleasure in reporting that we now have the co-operation of all the state institutions in the matter of tuberculin test for their dairy herds. A letter was sent in October, 1898, to the various state institutions owning dairy herds, offering to test their dairy herds, practically without expense to the institutions. The proposition was kindly received, but my suggestions were not acted upon, except in a very few instances. The superintendents of the other institutions reported that they felt that the test should be made, but for various reasons they were not ready for the test to be made. After waiting until June 9, 1899, I again wrote these institutions reminding them of the pre-

vious letter, and urging that the test be made as soon as convenient. I have received favorable replies from all these institutions, and the work of testing these herds has been completed for all of the state institutions excepting Rochester State Hospital, and this work will soon be finished, as I have received a letter from Dr. Kilbourne stating that they were ready to have the herd tested at our convenience. Dr. Brimhall has just finished testing a herd for the Indian School at Pipestone, and will test the Rochester herd soon as possible. At the St. Peter State Hospital they have been regularly and carefully testing their own herd for several years.

I can now report that your instructions concerning this work have been complied with, and this feature of this work is in excellent condition. This will not only protect the inmates of these institutions, and the herds belonging to the state, but it will also encourage neighboring owners, particularly breeders and dairymen, to have their herds tested.

I have not thought best in this report to weary you with the details concerning these various tests, but rather to summarize in the statement that these herds have been found comparatively free from disease. No general, or even serious, infection has been found among them. The demand for tuberculin during the past quarter has been so great that it has been frequently impossible to supply the needs of veterinarians and local health officers, but the Bureau of Animal Industry is dealing generously with us, and we are receiving large weekly shipments which supply the present demand. You will be pleased to learn that the city of St. Paul is also working in perfect harmony with us; in fact, I am furnishing all the tuberculin and mallein for the St. Paul work, and receiving very prompt reports of the work done.

There are some features of the tuberculin work which are very unsatisfactory, and our work is as yet very imperfect. We have no recognized system of marking tested cattle, and it is generally admitted that methods of marking are very imperfect. Minneapolis uses a system of ear tags, but these are easily removed. Veterinarians elsewhere in the state are branding with their thermo cauteries as a temporary measure, until some permanent system for the state is adopted. Early in the history of this work representatives of the state and Twin City boards discussed this matter, and agreed that the branding iron using the capital "T" would be a satisfactory way of marking the tuberculous or suspected cattle, and the State Board was to furnish the brands. I had six brand-

ing irons made, and distributed a portion of them, but, so far as I know, they have never been used, and I have thought best, for several reasons, not to insist on this branding. We cannot legally brand them as tuberculous on first test. The branding irons are inconvenient to heat, difficult to use when an animal is not closely confined, owners might object, with some reason, and we might meet with reasonable opposition from the Humane Society.

At a recent conference with the representatives of the St. Paul Health Department, it was suggested that a large punch be used instead of ear tags or branding, and I believe that this is the best system of marking that has been suggested. The proposition is to use large punches, place one hole in the left ear, towards the base, on all animals that give either positive or suspicious reactions on first test. Those that react on second test to receive another hole punched in the same ear. Cattle that do not react may be identified by common ear tags.

This method of marking by ear punch is rapid and simple, requires no elaborate preparation, and can be applied without confining the animals further than is necessary for the tuberculin test, and is permanent unless the entire ear is removed, and a cow with a left ear gone would be regarded with considerable suspicion. I have not conferred with Dr. Norton concerning this, but I hope that this system can be made general.

A still more unsatisfactory feature of the tuberculin work is connected with our quarantine in townships adjoining the Twin Cities. You will remember that at our last meeting I reported a number of cases where our quarantine had been violated, and where the chairmen of town boards were indifferent or actually unwilling to do the large amount of work necessary to impose and maintain satisfactory quarantine. This work is mainly for the city, and no provision is made for paying these local health officers for their work. It is scarcely reasonable to ask the chairman of Mound's View township or the health officer of Golden Valley, where there are many dairies, to leave their farms or other work day after day to impose quarantine and see that it is maintained. This troublesome feature was discussed quite fully in my last quarterly report, and I believe the matter was referred to our executive committee with power to act. Your committee held a meeting soon after our last regular meeting of the board, at which meeting this matter was discussed at some length. At the suggestion of Mr. Richardson, I was appointed a committee of one to formulate and present in writing a definite plan for doing

this work. The executive committee did not meet at the next appointed time. Since then two members of the executive committee went east, and the result has been that the whole difficulty is precisely the same as when presented at our last meeting, and that was not my first official mention of the matter. The health commissioners of both St. Paul and Minneapolis have offered to share with the state board the expense of maintaining such quarantine inspector, and it is unfortunate that this work could not have been inaugurated several months ago.

After our last quarterly meeting I continued to order quarantine for cattle suspected of being tuberculous until after the last called meeting of the executive committee. Since that time I have ordered no quarantine of cattle on account of tuberculosis, in townships adjoining the Twin Cities. I have taken this ground because I believe it the best for the stock interests of the state and the best for the present reputation and future work of the state board of health. I do not believe it wise for us to establish rules of any kind that we know will be persistently and openly violated. Neither do I believe it wise for us to issue any orders for quarantine that we know will not be respected and where we cannot force obedience. I am very anxious indeed that this matter be taken up and fully discussed and settled, if possible, at this meeting. I do not ask the board to establish this specific method of dealing with the difficulty, but I do urge that we establish some method that will be efficient.

The following proposition is offered for consideration:

First. That a quarantine inspector be employed by the board at a salary not to exceed $80.00 per month.

Second. It shall be the duty of this inspector to investigate at irregular intervals the condition of quarantine, chiefly among dairies near the Twin Cities.

Third. That this inspector shall do the work which we have previously expected of the chairmen of town boards.

Fourth. Correspondence from the director of the veterinary department ordering destruction, specifying conditions of quarantine, releasing quarantine, etc., shall be addressed to this quarantine inspector. It will probably be necessary for this inspector to do considerable driving, and I would recommend that the salary be so arranged that he shall be expected to maintain his own horse and buggy.

This quarantine inspector may be paid wholly by the state board of health, or jointly by the state and two city boards; but in any case he should be recognized as a state board of health

employe, under the management of and directly responsible to the state board of health. Both Dr. Norton, health commissioner of Minneapolis, and Dr. Ohage, health commissioner of St. Paul, have signified their willingness to pay a portion of the salary of such an officer, if we so desire.

During April, 400 head of cattle were tested, during May, 207, and during June, 172; total, 779 tested during the quarter. There were twenty-two cattle quarantined and four killed.

Governor Tanner of Illinois, has recently issued a proclamation which is intended to affect the importation into Illinois of dairy or breeding cattle. This proclamation forbids the importation of such cattle except under certain specified regulations. These regulations may be summarized as follows:

Rule 1 specifies that such cattle must have been tested with tuberculin by a veterinarian, who has been officially recognized by the proper officials of the state wherein he resides, before the cattle are offered for shipment to any railroad or other transportation company for transportation into the state.

Rule 2 specifies that before such cattle are offered for transportation into the state, the record of test, certificate of veterinarian, etc., must be forwarded to the Illinois Live Stock Commission for indorsement. The original copy as indorsed is returned to the owner, after which shipment may be made.

Rule 3 specifies the conditions of tuberculin test.

Rule 4 specifies that the certificate, etc., as indorsed, must be attached to the weigh bill or bill of lading, and delivered to the consignee.

Rule 5 specifies that when such cattle are shipped into the state without having complied with the conditions given in the preceding rules, they shall be placed under quarantine and continued therein until tested by a representative of the board of live stock commissioners. This test shall be made at the expense of the owner. Cattle which react shall be condemned and destroyed without compensation.

Concerning cattle already in the state, this proclamation takes essentially the same ground previously taken in our state board of health work, viz., that where the disease appears in a herd, or where there is good reason to suspect the presence of tuberculosis in any herd, all exposed cattle must then be tested; but no attempt is made to test indiscriminately all cattle of the state.

This proclamation also divides the cattle into six groups in which they are graded according to the extent and apparent dur-

ation of the disease. Owners are allowed from one hundred down to fifteen per cent of the appraisal for all animals slaughtered. Our neighboring state has taken a somewhat radical stand but it is evident that Illinois has made a long step in advance with her methods of handling bovine tuberculosis.

Sheep Scab—This board has adopted a circular containing rules for dealing with sheep scab and defining violation of quarantine, also some suggestions for local health officers; but it has not seemed best in view of our financial condition, to ask for their publication. I have thought best to revise this circular quite materially, and will re-submit it during the meeting for your consideration and with a suggestion that it be published soon as practical.

Since our last meeting, the governor of Montana has issued a proclamation under the authority of a recent act of the legislature for the purpose of suppressing and preventing the dissemination of sheep scab. This proclamation is of considerable importance to Minnesota stock interests. According to this order, all sheep imported into the state of Montana must be carried in properly disinfected cars. After unloading at the place from which they are to be taken to their final destination in the state, and before being released upon any public property or private premises, they shall be held at certain specified points and there dipped under the supervision of the state veterinarian. The dipping to be repeated within ten days. Sheep that have been driven into the state are to be similarly treated. After sufficient time has elapsed subsequent to the last dipping, if the inspector in charge or the state veterinarian is satisfied that the sheep are free from disease, they may then be conveyed to their final destination.

Other Diseases—Some of the more important outbreaks of other diseases are as follows:

Last April I received a letter from Dr. Cool, health officer of Faribault, concerning a serious hoof and foot disease that prevailed among cattle belonging to Mr. Dusbabek. Dr. Brimhall visited this place on April 19 and reports as follows:

April 21, 1899.

Cattle owned by Fred Dusbabek: Twenty-three cattle one year and older, 13 lame. The last of February, after feed had been changed from corn fodder to hay, the cattle seemed to drink more than usual, and many had diarrhoea. A number of them seemed uneasy, jerking hind feet and showing discomfort. Then three became lame at about the same time in the left hind legs. Other

cases soon followed. After a time the right hind feet became lame. The owner could not see anything to account for the lameness for some time, then the dead tissue began to separate, the skin at the top of hoof separated, and pus formed. I found six or seven of the older animals in very bad condition, some having lost part of the toes on the hind feet; others had lost whole feet and were greatly emaciated. An examination of the feet by cutting through the hoof in recent cases proved that the circulation inside of the hoofs was entirely obstructed, but there was no external signs of soreness. I was unable to find anything in the food to cause the trouble.

S. D. BRIMHALL.

Mr. E. A. Beckley, a prominent farmer of New Paynesville, called at my office about the first of May, asking for advice concerning a peculiar disease or possibly two diseases that prevailed among his cattle. The case seemed to justify such action and arrangements were made for Dr. Brimhall to visit his place. He reported as follows:

May 5, 1899.

On the farm of E. A. Beckley, of New Paynesville, I found the small calves affected with infectious dysentery, and among the older cattle there was a catarrhal fever which is evidently infectious. The temperature in different animals varied from 102 to 103 2-5. A throat cough, increased secretion from eyes and nose, loss of appetite for hay and rapid emaciation. Strange cattle brought on the place showed similar symptoms in three to six days. This disease is benign in its nature, but the dysentery is very fatal.

S. D. BRIMHALL.

In response to urgent telegrams from Herman, Dr. Brimhall was sent to that place on June 20 to investigate a serious outbreak of a strange disease among horses. The following is his report:

CEREBRO SPINAL MENINGITIS IN HORSES AT HERMAN, MINN.

I received a telephone message from Dr. Reynolds at 6 p. m., June 20, and took the 7:40 train for Herman. Met Mr. Hixson the next morning and drove about eight miles to his farm.

I found the neighbors thoroughly convinced that the horses had been poisoned, and they had gone so far as to pick out the offending party, a neighbor living near. An irregular veterinarian made an autopsy on one of the horses which had died and had decided that death was due to poison. There were four horses belonging to Mr. Hixson dead at the time of my visit.

The history of these cases, obtained from the man who was managing the farm, was as follows:

There were two horses taken sick on June 10, 1899; one of these, a stallion, lived only twenty-four hours. He seemed to be in much pain, frothed

at the mouth, and frequently bit at the woodwork of the stall. A mare which was taken sick at the same time died in about ten hours. She gave the same symptoms, except that she did not bite at the woodwork.

On Sunday, June 11, a pony belonging to a neighbor was placed in the stable for several hours and fed once. On the morning of June 16 the pony was taken sick with symptoms similar to those above described, and died on the morning of June 18, 1899.

A gray mare (No. 1) was taken sick Wednesday noon, June 14, and died the next day, June 15, with symptoms as noted above.

A bay mare was taken sick Friday noon, June 16, and showed much the same symptoms as the others, and died Sunday, June 18.

A gray gelding was taken slightly sick on Sunday, June 17, worse June 18, still sick when first observed by the writer, at which time he exhibited the following symptoms: Temperature 97 deg., pulse strong and regular, about 45 deg. Respiration quiet and easy. Sensation of skin absent over hind quarters. Sensation somewhat dull on other parts of the body. Tail muscles very weak. Some loss of muscular power; throat muscles partially paralyzed, making it very difficult to swallow. Horse seemed sensible to surroundings. Ulcers on under side of upper lip, probably due to bruising with the teeth. June 22 the temperature was 98.6 deg., other symptoms about as they were the day before.

Gray mare (No. 2) was taken sick June 19, 2 p. m., with symptoms much the same as the others. The symptoms present June 21 were as follows: Temperature 97.2 deg., pulse about normal. Symptoms same as horse, except that she ate very little. June 22, at 3 o'clock, temperature, 103.4 deg. Sensible to surroundings, neighing when approached. Wednesday, June 21, telegraphed to laboratory for assistance and materials for taking specimens. Dr. Wilson arrived Thursday morning, June 22, and we again repaired to the farm, and made the following examinations:

Thursday, June 22, 1899 at 11 a. m., gray gelding was killed by bleeding, and autopsy held immediately. Mouth filled with decomposed food; small ulcers on lip, as noted above. Gullet normal throughout. Trachea normal. Stomach showed near cardiac orifice a patch of confluent erosions. Papillae over greater curvature were swollen and injected. Stomach empty except small amount of fluid. Intestines moderately distended with gas; formed faeces in small colon. Liver, spleen and kidneys normal. Adrenals contained many calcareous nodules. Bladder filled with apparently normal urine. Lungs apparently normal, except hard nodules about one-eighth of an inch in diameter over surface. Pericardial sack moderately filled with clear fluid. Heart apparently normal. Brain, cervical cord and portion of lumbo-sacral cord removed. When the spinal canal was opened a very large amount of a yellowish cloudy fluid escaped. The meninges of the brain near the opposing surfaces of the cerebrum and cerebellum covered by a yellowish, plastic exudate. The vessels at the base of the brain were markedly injected. The vessels of choroid plexus congested. Brain substance itself appeared normal. Pia surrounding the medulla and cord and all of the portions of the cord examined were cedematous and markedly congested. Substance of the spinal cord appeared normal.

Cultures were taken from the liver, spleen, cerebro spinal fluid and base of brain. Direct coverslip preparations were made from the yellow

exudate at the posterior poles of the cerebrum and from the base of the brain.

Portions of the stomach, liver, spleen, adrenals, base of brain, medulla, cervical and lumbar cords were preserved in 96 per cent alcohol and 10 per cent formalin for future study.

Gray mare (No. 2) was killed by bleeding at 2 p. m., Thursday, June 22, and an autopsy performed immediately. Findings were in all points like those in horse noted above except in the following particulars: Erosions in stomach were slight and the papillae were normal. The hard nodules in the lungs were more numerous, and similar ones were found on the liver, capsule of the kidney and peritoneum. (Mare was nine years old and the water of the vicinity was markedly alkaline.)

Lesions of central nervous system more marked than noted in horse. Uterus contained foal about ten months or over. Alive and in apparently good condition. Coverslip preparations, cultures and specimens for histological examination were taken from the same location as noted in the horse, and in addition coverslip preparations and cultures were made from the base of the brain of the colt, and a portion of its cervical cord was preserved for histological examination. The central nervous system of the colt had not been drained of its blood, but otherwise presented no abnormal appearances.

S. D. BRIMHALL.

ENLARGED WORK.

The additional appropriation which the legislature kindly gave us last winter becomes available August 1, and we have now to consider the possibility of enlarging our work in the veterinary department. I beg leave to make the following recommendations:

First—That we employ one, or possibly two veterinarians, depending upon future hog cholera developments, for field work during the coming summer and fall, especially for the purpose of doing work in connection with hog cholera. It will probably be advisable to do a considerable amount of field work similar to that done by Dr. Annand last year. This work should probably be done mainly through a narrow strip of country just south of the territory in which Dr. Annand worked last season; in other words, I propose to put up another wall across the state, beginning south of the old one, this wall to consist mainly of chairmen of town boards who are fairly well informed concerning the nature of hog cholera, the necessity of prompt action in case the disease appears, and as to just what action should be taken.

Second—That we establish the policy of more frequently sending veterinary assistance to local health officers, and for the state board in this way to take a more active and direct charge of certain outbreaks of disease. I find that after a township has em-

ployed a veterinarian and had a considerable amount of work done, then horses, for instance, are quarantined and a re-test must be made, township officers are somewhat loath to involve the township in further expense. I have therefore made it a sort of routine custom, in cases where the township officers have already done considerable work and involved the township in as much expense as seemed reasonable to ask of them, to send Dr. Brimhall to finish the work. It will probably be advisable in the future to enlarge this feature of the work.

Third—That we use such portion of this fund as seems advisable for research work.

ALTERATION OF RULES.

I wish to propose the following alteration in number 2 of "Rules Concerning Work in the Veterinary Department": That this rule shall be so amended as to read as follows:

"The director shall conduct the correspondence dealing exclusively with veterinary matters, and he shall have the necessary police authority to enable him to kill, or order animals killed, to impose quarantine and prescribe conditions of quarantine in accordance with the law dealing with infectious diseases of animals and the rules of the state board of health. He shall have authority to use his judgment in releasing quarantine in unusual cases independent of the rules governing quarantine."

The reasons which I have to urge in support of this amendment is chiefly that the present rule gives the director authority to quarantine, etc., but does not give specific authority to order diseased animals destroyed, when such course becomes necessary, whereas in No. 6 of these same rules, specific authority is given to the field veterinarian to kill. This was undoubtedly an oversight, as the director conducts the correspondence and is expected to manage this portion of the work.

Respectfully submitted,

M H. REYNOLDS,

Director.

SEPT. 30, 1899.

During the past quarter the work of this department has been of the usual routine character, but has been enlarged in some respects and some advance work accomplished. We have added one field veterinarian for the hog cholera work especially, and

also a quarantine inspector. You will remember that in my last report I mentioned the very unsatisfactory condition of our tuberculosis quarantine work in townships adjoining the Twin Cities, and recommended the employment of a quarantine inspector. Since the quarantine inspector commenced work, August 1, there has been a very marked improvement in this respect. Further discussion of this hog cholera and tuberculosis work will be given later. I will have some recommendations and suggestions to make for your consideration.

Glanders—The work with glanders during the past year has been unusually satisfactory. Quite a number of badly diseased horses have been found and destroyed, without friction with others.

GLANDERS RECORD.

Month	Killed Without Test.	No. Tested.	No Reacted.	Killed on 1st Test.	No. Quar'tined.
July	5	71	29	20	16
August	2	61	30	23	7
September	2	58	48	30	23
Totals	9	190	107	73	46

The following brief table gives the record for the corresponding quarter of '97, '98 and '99:

	Tested.	Killed.
1897	199	62
1898	63	16
1899	191	63

It is gradually becoming a matter of general information throughout the state that the mallein test is reliable and practical, the only means we have of making positive diagnoses in doubtful cases, that the state board of health rules require that all horses which have been exposed in the stable shall be tested, and that glanders is more common than people had previously realized. Health officers and veterinarians throughout the state are becoming better informed concerning the state board of health regulations and methods.

Our most difficult problem in this connection is the control of glanders in the larger cities. It is much easier to enforce thorough measures in the country or in smaller places, but our regulations and methods are gradually becoming better enforced in the

larger cities, and I think we may reasonably expect that the time will soon come when our measures can be as thoroughly enforced in the city as elsewhere.

Hog Cholera—Hog cholera has probably been very much less prevalent this year than during the corresponding quarter of 1898 and preceding years, but it is very difficult to estimate accurately the extent to which this disease has prevailed. As will be noticed, Dr. Annand has made several trips into different portions of the state, partly for the purpose of estimating the extent to which the disease has prevailed, particularly in the southern portions of the state, where the disease has been most common in previous years. Information thus far received indicates that the disease has prevailed in twenty-three townships in twelve counties, distributed as follows:

Polk 6, Renville 1, Watonwan 4, Martin 2, Fillmore 1, Winona 2, Wabasha 1, Olmsted 2, Scott 1, Carver 1, Wright 1, Pine 1.

It is apparent that hog cholera has prevailed in places from which we have had no report, and that local health officers who have been previously informed as to the nature of the disease, and their duties in connection with it, have neither reported to the state board of health nor taken any active steps looking to the enforcement of our rules and the checking of further spread.

Our hog cholera regulations now in force order, among other things, that hogs must not be taken from any railway shipping pen, from certain specified counties, except for immediate shipment from point to point in Minnesota, or from another state into Minnesota, and not intended for immediate slaughter or exhibition at the state fair, must be crated, shipped in other than stock cars, and accompanied by a certificate stating that they were free from the disease when shipped, etc. Further, that hogs intended for such shipment in crates must not be permitted in, nor loaded from stock yards. I am inclined to suspect that some of our present trouble in connection with hog cholera has been caused by violation of these regulations, but have no specific information or proof to this effect. I have instructed Dr. Annand to bear this in mind and investigate carefully at every opportunity, as I deem it quite important for us to know just how thoroughly our various regulations are obeyed.

The present hog cholera situation differs quite materially from that of previous years in that outbreaks can usually be traced to some farm where they have been raising hogs year after year

in pens where hog cholera has previously prevailed. Our most extensive outbreak is in the neighborhood of Crookston, involving six townships; but I do not anticipate that this will be a very difficult outbreak to control, or that great harm will hereafter result from it, because of the fact that the country east of this outbreak is very sparsely settled. There are comparatively few hogs north or south, and on the west we have the Red River of the North as a state boundary, with the current running northward into a district where there are very few hogs.

I wish to note especially in this connection, an outbreak which occurred at Winona, and the very prompt and efficient measures that were adopted by our president. We were so fortunate in this case as to have for local health officer the president of the state board of health, and the way this outbreak has been managed should be a good object lesson for other health officers.

Tuberculosis—I am pleased to report that the work with tuberculosis is in a much more satisfactory condition than at the time of my last report. The problem of dealing with owners of tuberculous cattle in townships bordering on the Twin Cities seems to have been solved by our plan of appointing a quarantine inspector, as urged in my last report. Mr. Pomplum was employed as the quarantine inspector early in August, and since he commenced work there have been reported no serious violations of quarantine outside the city limits; i. e., of cattle tested since he commenced work. He has had some rather unpleasant experiences where the owners had previously violated quarantine. Ear tag numbers have been exchanged or removed in a few instances. He has succeeded in securing the slaughter of quite a number of cows that were supposed to have been killed some time ago, but concerning which it had been difficult to get authentic information. A number of cattle which have been killed since his work began should have been killed some time ago, but these old cases are practically all taken care of and the work is moving nicely.

In my last report I stated that 172 cattle had been tested in June, but since that time I have received reports of 491 other animals which should have been included in the June report; making a total of 663 cattle tested in June. These are not included in the following report:

Month	No. Tested.	No. Retested.	No. Quar'tined	Killed on Retest.	Released On Retest.	Killed on First Test.
July	981	44	44	2	1	..
August	394	16	18	12	..	..
September	486	31	12	..	2	19
Totals	1,861	91	74	14	3	19

The total number of cattle in quarantine at the close of this quarter is sixty-nine.

I wish to call your attention especially to the fact that I am able to give you accurate and positive records for this work during this quarter. This is the first report in which I have ever been able to give such data. It is much easier to keep our records straight under present conditions, and I attribute this very largely to Mr. Pomplum's work, of which the following is a summary:

Date.	Township.	Owner.	Remarks.
Aug. 7, 1899	Rose	G. Lunde	First visited Aug. 7; cow killed Sept. 22. Made five or six calls between these dates, usually when passing the place on other work. The cow had been removed from quarantine and placed in another pasture. Had dificulty in locating the cow, but the case was finally dispos'd of, as stated
Aug. 5, 1899	Rose	Niel McCallum	2 cows in quarantine, one released on retest, one reacted and killed.
Aug. 7, 1899	Fridley	A. D. Therres	New cases, 1 cow quarantined.
Aug. 8, 1899	Fridley	John Therres	New cases, 3 cows quarantined.
Aug. 8, 1899	Fridley	Ridel & Nelson	Old case, 3 cows found and quarantined.
Aug. 7, 1899	Mounds View	James McCallum	Called three times between this date and Sept. 22, for the purpose of killing the cow which should have been killed some time ago. Made several dates with the owner, but owner did not do as agreed. Cow finally sent by owner to slaughter house at Transfer. (*)
Aug. 23, 1899	Min'etonka Mills	H. G. Johnson	Visited the place five times, four cattle killed, carcasses condemned Sept. 15.
Sept. 17, 1899	Bloomington	L. Drongenson	One cow killed and condemned.
Aug. 16, 1899	Richfield	B. F. Irvine	New cases, one cow quarantined.
Aug. 15, 1899	Golden Valley	J. E. Foss	Cow killed and passed Aug. 25.
Aug. 15, 1899	Golden Valley	Chris Nielson	Considerable trouble over this case, finally disposed of by slaughter Oct. 25. Carcass passed.
June 15, 1899	Min'etonka Mills	C. Christenson	1 cow killed and condemned June 25.
June 15, 1899	Golden Valley	Anderson & Peterson	Investigated case of glanders concerning which I had been unable to get satisfactory information. Found everything satisfactory but not reported.
Aug. 24, 1899	Hopkins	A. T. Anderson	1 cow killed, carcass passed Aug. 25.
Aug. 23, 1899	Min'etonka Mills	Nielson & Beckerson	New case, 4 quarantined.
Aug. 24, 1899	Crystal	P. Johnson	1 cow killed and passed.
Sept. 15, 1899	Fridley	C. C. Hays	Owner not home, old case.
Sept. 14, 1899	Richfield	Nodell & Son	An old case, found that cows had been sold and slaughtered without inspection.
Aug. 5, 1899	Mounds View	P. O. Peterson	Investigated quarantine of glandered horses and found that they were obeying quarantine. Also investigated quarantine of horses in care of John Skiba and found quarantine all right.

*This cow was taken to slaughter house at transfer on Oct. 5. Could not reach Mr. Pomplum, and arranged for Mr. Tillbury to inspect.

Mr. Pomplum also spent several days inspecting rendering establishments and slaughter houses about the Twin Cities. Data given to Dr. Bracken, and will doubtless be included in his report.

Anthrax—As noted in my report of Dr. Brimhall's work, we had an outbreak of anthrax during this quarter. The circumstances of the case are such that it is rather improbable, though not by any means impossible, that we should have further trouble from this source. For report see summary of Dr. Brimhall's work.

NEW PUBLICATIONS.

Since my last report we have issued the following circular on sheep scab:

SHEEP SCAB.

The State Board of Health has published a circular giving information concerning sheep scab. This circular is for free distribution to the farmers of the state. Sheep scab is caused by minute parasites which may either burrow into the skin or live upon the surface. The disease is spread only as the parasites themselves are scattered, usually by the sheep themselves. Local health officers are urged to make themselves familiar with the symptoms and nature of this disease in order that they may be helpful in case of an outbreak.

When sheep begin to show symptoms of any suspicious skin disease the fact should be reported at once to the local health officer. See Section 2 of Chapter 233, Laws of 1897, "An Act to Prevent the Spread of Contagious and Infectious Diseases among Domestic Animals in this State."

Health officers must quarantine such animals at once and explain to the owners or keepers the nature and conditions of quarantine. They must see that these conditions are rigidly enforced until quarantine is released.

RULES OF QUARANTINE.

1. Animals affected with sheep scab are hereby held to be affected with a contagious or infectious disease as designated by the law of this state, and the rules of the State Board of Health. All persons and corporations are hereby forbidden to transport such diseased sheep from any point outside the state to any point within the state, or from place to place within the state, except upon permission in writing from the State Board of Health.

2. Animals that may be reasonably supposed to be affected with sheep scab shall not be allowed to enter any stock yard or other public place where they may come in contact with healthy sheep or where healthy sheep are liable to be placed.

3. All outbreaks of suspicious skin disease among sheep must be quarantined and at once reported to the State Board of Health.

4. All sheep affected with scab or which show any inflamed condition of the skin, and all sheep that have associated in the same flock with such sheep, must be included in the preliminary quarantine.

5. Quarantine must be continued until satisfactory evidence is presented to the State Board of Health that the quarantined animals are not affected with sheep scab or until the entire flock has been dipped two or more times with intervals of eight days, using a recognized dip according to instructions. (See "Circular of Information Concerning Sheep Scab.")

6. Enclosures wherein sheep affected with scab have been confined must be continued in quarantine for a period of at least eight weeks after such diseased sheep have been removed.

VIOLATION OF QUARANTINE DEFINED.

It shall be deemed a violation of quarantine for any person to knowingly remove, authorize or cause to be removed any sheep that have been quarantined on account of any contagious or infectious disease, from any farm or enclosure where they have been quarantined, except as provided in rule five (5).

It shall be deemed a violation of quarantine for any person to knowingly cause, authorize or permit to be placed any sheep, except those already quarantined, in any stable or enclosure that is under quarantine on account of any contagious or infectious disease of sheep.

"An Act to Prevent the Spread of Contagious and Infectious Diseases among Domestic Animals in this State." (Act of 1897.)

"Section 9.—Any person violating any provision of this act, or any rule or regulation made by the State Board of Health, or by any local board of health, or any order made by any such board under the authority hereof, shall be guilty of a misdemeanor and shall be punished by a fine of not less than twenty-five (25) or more than one hundred (100) dollars, or by imprisonment for not less than thirty (30) or more than ninety (90) days."

I have in mind a circular of information concerning sheep scab, which has been discussed in the executive committee meeting, and will be gotten out in the near future. This will finish the series of placards, rules and circulars of information, which I have had planned for some time. This circular of information will be quite similar in plan and purpose to our hog cholera circular.

Eastern Trip—I have already furnished Secretary Bracken with a statement of my expenses on this trip. I take pleasure in reporting a pleasant and profitable trip, during which I had the pleasure of a great many personal visits with the most prominent and progressive veterinarians of America. I attended the 36th annual meeting of the American Veterinary Medical Association, Association of Experiment Station Veterinarians, and the Association of Veterinary Faculties; all of which met in conjunction, early in September, in New York City. The attendance was unusually large, and the programme was one which I could not have afforded to miss. Considerable attention was given to consideration of

state sanitary measures. It seemed to be an opinion generally entertained by those who have had most experience with state work of this kind, that the state should, under certain conditions, reimburse owners, when animals affected with infectious diseases are destroyed by the state. This opinion is maintained on two grounds: First, that it is justice to the owners; and, second, it enables the state authorities to do more thorough work. There is less reluctance on the part of owners and health officers to report; less friction with owners; less temptation to violate quarantine, and conceal the existence of such disease.

Quite a number of states, including Massachusetts, Pennsylvania, Vermont, Virginia, New York, Illinois, and Minnesota, are trying to solve the problem of dealing with bovine tuberculosis. The methods vary somewhat in different states, and the work is necessarily somewhat crude, as it is a comparatively new problem.

Confidence in the accuracy of tuberculin and realization of its importance were universal. Nearly all of the states that are attempting to deal with this problem, test cattle free of expense to owners; in some states only upon requests from owners. Condemned cattle are slaughtered immediately and owners partially reimbursed. As a rule, these states quarantine against cattle coming from other states without certificates of test, especially with a view to preventing the importation of breeding and dairy cattle.

The subject of rabies came up accidentally in one of the dis-ished at the prevalence of this disease, which was reported from nearly every state represented at the meeting. The prevalence in the District of Columbia was especially noticeable. The matter was thought of sufficient importance to justify a series of resolutions.

Veterinarians engaged in state work are all anxiously waiting for a hog cholera vaccine that will be successful as a preventive, and practical in the matter of concentration, expense and care of administration.

SALARY OF EMPLOYES.

I wish to recommend that Dr. Brimhall's salary be raised from $1,800 to $2,000; and Miss Carroll's from $40 to $50 per month. I think that sufficient reasons can be given for these changes when the matter comes up for consideration.

DECEMBER 31, 1899.

Glanders—State control of glanders involves two fundamental propositions—protection for the public and protection for the individual. The first is not apt to be overlooked, but there is a tendency to give too little attention to the second. It is undoubtedly possible in many outbreaks of glanders to protect the public without involving the owner in heavy loss or inconvenience. There is no longer serious question covering the proper disposition of clinical cases, and the majority of veterinarians are agreed as to the proper disposition of horses which react on mallein test and show any of the recognized clinical symptoms. The difficult question is involved in the proper disposition of horses which react on mallein test but show no external symptoms. I think there can be no question but that it is important to have such horses under observation, to know where they are and watch for possible development into clinical cases. A few of these cases are undoubtedly infectious; for instance, we recently found one case in Anoka county which showed apparently no symptoms of the disease. This horse had been tested three times at intervals of several months, the first time giving an uncertain reaction, but each reaction was more pronounced. This horse was killed after the third test, and on postmortem showed typical lesions of glanders in the larynx and trachea. It is probable that this horse was infectious all of the time and should have been destroyed after the first test. It is also probable that many of these reacting but non-clinical cases are not infectious, but we have no means of selecting.

I have corresponded and conversed with nearly all of the prominent veterinarians in the United States who are doing this kind of work, and I have found no good reason for recommending any radical change in our present rules or accepted methods of dealing with this disease. It has been our common practice to insist on the disposal of the obviously glandered horses, and those which react and show any of the recognized symptoms of glanders, according to directions given in "Rules and Suggestions Concerning Glanders-Farcy." Our rules leave the disposition of the reacting but non-clinical cases to the judgment of local health officers, merely insisting that such horses must be either killed or quarantined for re-test, and that they must not be released from quarantine unless they fail to react under future re-test. It has been my custom in unfortunate cases where a very large number, or

practically all of a man's horses react, to recommend the local health officer to consult with the veterinarian in charge, and the owner, and select one team, or if advisable two teams, and give the owner permission to use these horses upon the road, under certain restrictions concerning stabling, watering and use of public hitching posts. It may be found advisable, as experience in this line accumulates, to quarantine all reacting, but non-clinical, horses in this way. I do not believe it wise for us to attempt doing this work entirely by mechanical rule to the neglect of the individual or personal element. The veterinary sanitarian who tries to do his work in that way will certainly stir up an opposition that will ultimately ruin his work. We cannot afford to lose the confidence and moral support of veterinarians and stockmen. When we do that our work fails.

It is evident that glanders is seriously prevalent, more prevalent than people have usually supposed. The mallein test has already revealed a serious prevalence of glanders where we had previously no reason to suspect the presence of this disease. Post-mortems usually support the mallein diagnosis, and we have been forced to the conclusion that this is a larger and more serious problem than people have commonly realized.

I take pleasure in reporting that we have had no serious trouble with either owners or local health officers during the past year. Quite a number of animals have been killed under protest, but the post-mortem examinations have supported the position taken by the state board and we have had no bills to pay on this account.

I have become fully convinced that it would be of material assistance to this work, and in most cases nothing more than bare justice to owners, if we could pay a reasonable compensation for horses destroyed in the process of this work. There would be less hiding of these cases; they would be reported more freely to local health officers, they would not be traded about so much and owners would feel more kindly toward the work.

During the past quarter there have been made 123 original tests of horses, 44 re-tests, 5 horses killed without test, 35 killed on first test, 12 killed on second test; a total of 52 killed during the quarter. Twenty-two horses were quarantined on first test and 21 quarantined on re-test. The following table makes a comparison of the number of horses tested and the number killed during 1897-8-9:

	1897.	1898.	1899.
Number tested	391	381	490
Number killed	180	165	168

The following comparison is submitted as illustrating the results of our work. These counties have been selected merely because they were counties in which it was possible to make comparison for three years.

The following is a record by counties for the past quarter—

GLANDERS.

Counties—	1897.	1898.	1899.
Polk	32	16	5
Carver	30	2	0
Chippewa	32	4	0
McLeod	11	0	0
Winona	8	0	1
Kandiyohi	8	0	3
Redwood	6	0	0
Faribault	7	2	1
Totals	134	24	10

Hog Cholera—I have not been pleased with the progress we have made with hog cholera during 1899. The trouble has been mainly that local health officers have realized that if they reported hog cholera it meant considerable work and some personal annoyance. Owners have learned that if hog cholera is reported as existing on their farms they are put to some inconvenience. Although they are not usually caused much financial loss they are put to considerable inconvenience, and as a result, owners have not reported to local health officers as the law says they must do, and local health officers have not reported to the state board as the law says they must do. We are at a critical point in this work, and after the very satisfactory progress that was made in 1897 and 8 it would be very unfortunate if the work was allowed to lose ground, merely because a few individuals are put to some inconvenience.

During the recent progress of this work, Dr. Annand's reports indicated that in one of our southern counties there had been a number of glaring violations of the law, and the rules of the state board of health. Several chairmen of town boards admitted that they had been notified of the existence of hog cholera, that they had received specific instructions from the state board of health, and that they had taken none of the steps which the law orders. We also secured clear evidence in certain cases that owners had hog cholera upon their farms, knew that it was hog cholera, and failed to report to the local health officers. I also received definite information concerning the violation of our hog

cholera regulations referring to railroad shipment, and concerning another instance where hogs had been taken by a farmer to railroad shipping pens, there sold to a dealer who in turn sold them to another farmer. This farmer took them to another neighborhood in the country, and the result was a serious outbreak of hog cholera. These hogs were evidently not infected when they reached the stockyards. We thus had apparently clear evidence concerning the four essential points upon which the success of our entire hog cholera work depends. After some consultation with Dr. Bracken, who was very busy with other work at the time, I made arrangements through him for a conference with Mr. Richardson, concerning the needed evidence and the best methods of going about the work. Dr. Annand was then dispatched to the neighborhood previously referred to, with instructions to make a thorough investigation, secure the desired evidence and to stay long enough to thoroughly accomplish the purpose, it being our thought that it would be wise to do this thing on a rather large scale, and in one portion of the state, as a matter of business economy. After thorough investigation and considerable work, Dr. Annand returned with what appeared to be a satisfactory lot of evidence. This was referred to Mr. Richardson, who has the matter under consideration. I would urge if Mr. Richardson considers the cases good enough, that all of them be pushed vigorously, and that the result, if favorable, be used in such a way as to have the best moral effect upon the public. Our present plan of dealing with hog cholera cannot possibly succeed further unless we can have prompt reports concerning outbreaks, and I know of no way to secure prompt reports except by punishing those who offend in this way. This enforcement of law will never be accomplished if we depend upon local health officers to institute legal proceedings and prosecute the offenders.

During the last quarter, thirty-nine townships in nineteen counties have been reported as having hog cholera. The actual infection is probably much larger, but we have no means of estimating more accurately. The following table gives a reasonably accurate view of the hog cholera situation for the years indicated. It is probable that the number of townships and the financial losses indicated for '98-'99 should be somewhat larger. The present work began in 1897. The financial loss for 1896 was based on estimates made from reports of about 500 prominent stockmen and farmers scattered throughout the infected area. The estimates for 1897-8-9 are based on township reports. Climatic and general

conditions other than those resulting from our work must be credited for considerable of this showing, but it is difficult to estimate how much.

HOG CHOLERA.

Year—	Counties infected.	Twps. infected.	Loss.
1896	43	...	$1,000,000
1897	41	254	487,500
1898	32	93	325,000
1899	32	75	252,000

Tuberculosis—I have made a special effort during this quarter to interest prominent breeders in the development of some project to encourage owners of pure bred cattle to take a more active interest in this work, and secure a voluntary testing of such herds throughout the state. The plan suggested by Dr. Bracken as being in successful operation in one of the Eastern states has not been favorably received. This plan involved a proposition to breeders that if they would have their herds tested voluntarily and submit records of test to the state board of health, we would, upon approval, issue a certificate recognizing such herds as free from disease and recommending them to intending purchasers. Breeders with whom I have advised, feel that the mere fact of testing operates seriously against the financial interests of the owners. Purchasers apparently prefer to buy from herds concerning which they know nothing than from herds which, as they can easily know, have been tested and cleaned out. It is my purpose to present this subject in a paper before the coming meeting of the State Agricultural Society and ask for a conference with representatives of the State Agricultural Society, Stock Breeders' Association, and Experiment Station, and possibly we may have a representative from the State Dairy Association. I believe that such a committee could be interested in this work, and if we can induce the committee to take the initiative we may secure favorable results.

A convention for the discussion of tuberculosis is to be held in Des Moines on January 9th, at which meeting this subject will be thoroughly discussed. The writer was invited to take part in this discussion but could not accept on account of the conflict in dates with the meeting of this board. The Iowa State Veterinary Association meets in Des Moines on the 10th and 11th of this month, an expressed purpose of this association being to bring as much

personal influence as possible to bear on legislators with a view to encouraging needed legislation along this lone. The writer received an invitation to take a place on this programme also, but could not do so for the reason just given. This discussion of the subject in Iowa, coupled with the fact that Illinois has already adopted measures for preventing the importation of dairy and breeding cattle without tuberculin test, should be quite suggestive to Minnesota breeders and sanitarians. The writer has hitherto been unwilling to support measures similar to those adopted for Illinois so long as our own cattle were probably not less affected with tuberculosis than those of adjoining states, but when neighboring states adopt these measures, we will be compelled to do likewise or Minnesota will become a dumping ground for tuberculous cattle. A great many cattle, particularly for dairy purposes, are shipped into Illinois each year from Minnesota and adjoining states. The cattle which react under these tests in Minnesota are naturally left upon the hands of the state board of health. Cattle which react under these tests in Iowa or Dakota or Illinois may be shipped into Minnesota, the sound cattle going on to Illinois. It is true that we have the protection afforded by regulations which have been adopted by the National Department of Agriculture, but it is probable that we will soon need some state protection as well. Pennsylvania and Massachusetts and perhaps a few other states have such regulations already in effect. The subject has been agitated in Wisconsin to a considerable extent. It may be only a question of time until Minnesota will be compelled to take a similar position.

During the past quarter there have been tested in this state 2,768 cattle, of which 138 reacted and 25 were killed. This gives us an average of about 5.1 per cent of reactions for the entire state. During the previous quarter 1,861 cattle were tested, of which 95 reacted, or about 4.9 per cent reactions, and 33 were killed.

The work with dairy herds of the various state institutions is now in a very satisfactory condition, although we are unable to get the work done as regularly each year as we would like. All of the state institutions are having their herds tested except one. (Red Wing, which has not reported.) I take for granted from the tone of our correspondence and from what Dr. Brimhall reports of the treatment accorded him at these institutions that our work is kindly received. We have found tuberculosis during the past year in all of these herds, but in no case has the infection been very serious.

Other Diseases—Quite a number of outbreaks of diseases among domestic animals has been reported through various portions of the state. Some have been investigated and others have been attended to entirely by correspondence.

Corn stalk disease has not been reported this year. Black leg has not prevailed to a serious extent, although small outbreaks have been reported from several places in the western portion of the state. Veterinarians and stockmen are now making free use of black leg vaccine, and outbreaks of this disease are therefore easily managed.

On October 31 I received a telephone message to the effect that some disease, possibly rabies, had appeared on three farms near Hugo. Drs. Brimhall, Wilson and Martelle visited these farms on the following day, and found a very interesting situation. The outbreak affected dogs, cattle, sheep and pigs. The symptoms in all cases were apparently those of rabies. Material was taken for laboratory examination. This interesting outbreak will doubtless be reported in full from the bacteriological department.

November 18 and 19 Drs. Brimhall and Wilson went to Forest Lake, for the purpose of investigating a disease among cattle belonging to Mr. A. O. Stromberg. One steer had died November 2 after a brief illness; no obvious symptoms, except diarrhoea. November 16 another which had appeared to be in perfect health in the morning, was sick at noon, refused food, was weak, and died about 6 a. m., after being sick about eighteen hours. Post mortem examinations on November 19 gave but little information, the only evident lesion was a moderate inflammation of the mucous membrane of the abomasum. Materials were taken for bacteriological examination, and this will also be doubtless reported from the bacteriological laboratory.

An interesting outbreak of rabies among cattle is reported from Montevideo, occurring in the practice of Dr. B. Lambrechts of that place. The diagnosis was sustained by laboratory findings.

Reimbursement—During the course of my experience in this work I have gradually come to the view that it is wise for the state to reimburse in part, particularly for horses that it may be necessary to destroy in this line of work, but it is doubtful if we could make satisfactory arrangements to reimburse owners for horses only when we are also condemning other animals for slaughter. It is now generally agreed among veterinary sanitarians that this is the ideal method, and in many cases the more practical method

--that of partial reimbursement. In the case of glandered horses the payment could be graduated according to the class of subjects, and in any case the reimbursement should only be partial. There are many arguments in support of this view. Owners would receive the work more kindly; cases would not be concealed so long and result in such widespread infection; glandered horses would not be traded about so much and cause so much expense in tracing them up and taking care of the glanders scattered in this way. It is probably only justice to owners in many cases, and reimbursement would relieve the state board of one of the most unpleasant features of this work—the necessity of killing or quarantining horses belonging to people unable to bear the loss and inconvenience. I could point to many instances which have occurred during the course of this work where very severe hardships have been worked upon innocent owners, and that in spite of special efforts to lessen the loss and inconvenience in every way that was deemed wise and safe.

I would respectfully urge that the board take this matter under consideration with a view to asking, at an appropriate time, for some revision of our present law bearing on this subject.

Section 4, paragraph 2, referring to re-tests of cattle, should also be modified. My present thought is that the necessity for retest should be done away with, but that owners should be given a reasonable time after the test in which to prepare cattle for slaughter if they wish to do so.

Section 5 of the law dealing with infectious diseases of domestic animals is so worded as to imply that appraisal should be made after the killing and post-mortem. As a matter of fact this should be done before post-mortem.

I would respectfully recommend that this board publish a small pamphlets containing all of the rules, circulars, etc., and reduced copies of the large placards used in this department, and that these pamphlets be distributed quite freely among local health officers. I find that local health officers are apt to lose copies of our rules, blanks, circulars, etc., which are sent them. A pamphlet of this kind would doubtless be preserved, kept in a convenient place and the health officer would be much better informed concerning duties and methods.

JULY 1, 1900.

The condition of the work in this departmnet during the past six months has been gratifying concerning both the situation in

regard to infectious diseases of animals and the amount of satisfactory work that has been accomplished. It is with some regret that I present this, my last report as director of the veterinary department. I think that this board is already well informed concerning the circumstances in this case, and I need make no further explanations. It is with pleasure that I contemplate the fact that although it has not seemed best for me to attempt to continue carrying the active work that naturally goes with the management of this department in connection with my University work, that I may still continue as a member of this honorable board, and assure you that my interest in the work will continue unabated.

Glanders—The glanders situation may be briefly summarized as follows:

Number of horses tested in first half of 1900	191
Number quarantined on first test	27
Number killed on first test	47
Number killed on second test	4
Number quarantined on second test	29
Number retested	84
Total number killed	51
Total number killed during first half of 1899	51
Number cattle tested with tuberculin during first half of 1900	4,374
Number killed on first test	80
Number killed on second test	79
Number retested	149

One of the most interesting cases of glanders which have been dealt with during the period included in this report occurred among a lot of eighteen range horses and two mules at Worthington. These animals had recently been shipped in from Nebraska. The local health officer had very promptly held these animals in the railroad shipping pens and had also held the car in which they had been shipped. A representative of the freight department of the "Omaha" called on me for the purpose of getting advice concerning the proper procedure, in order that quarantine might be released as soon as possible. Dr. Brimhall was dispatched to Worthington at once, reaching there March 12th. These were wild range horses and of course could not be tested with mallein. One horse and one mule were found showing clinical symptoms of the disease. The other animals were released from quarantine in the yards as soon as the two clinical cases had been destroyed, and were kept in pasture near Worthington for a suitable period

in order that they might not be disposed of before other clinical cases would have time to develop. The stock car and yards were released as soon as disinfected. I have reason to think that the railroad company, as well as the local authorities and citizens of Worthington, were well pleased with the outcome of this case.

The following telegram was sent to Dr. Gould in response to inquiry:

"March 13. Dr. J. N. Gould, Worthington, Minn. Release horses as soon as the two are killed. Release car as soon as disinfected.

(Signed) "M. H. Reynolds."

No other cases developed and the herd was released.

Concerning the work with glanders, I care to say only that our state work is progressing in a satisfactory way, and I am not inclined to recommend any radical change in our present plan of dealing with this difficult problem. Intelligent owners are gradually coming to understand that a horse may be affected with glanders and yet show no external symptoms of the disease, and that such an animal may or may not be infectious to other animals, but that it is necessary and reasonable to treat such animals as though they may be, or become at any time, infectious. I have but two suggestions in this connection. (See suggested alterations for "Rules and Suggestions Concerning Glanders-Farcy.") One is to the general effect that under favorable conditions this board can be more lenient with owners of reacting but non-clinical horses. Hitherto it has been our plan, when several or perhaps nearly all of the horses belonging to any owner react under mallein test, to permit the use of one or, in some cases, two specified teams upon the road under certain conditions. I am not inclined to recommend that this permission be made general for all reacting but non-clinical cases. The conditions under which such animals may be used, to remain the same as at present, viz., that they are not to be watered in any public watering trough or tank, tied to any public hitching post or rack or placed in any stable other than the one wherein they have been quarantined.

The other suggestion is to the effect that cases which react but show no clinical symptoms at the time of test, may either be (1) killed at once; or (2) continued in quarantine for re-test after thirty days, and within a year, at the expense of the city, village, or township where the animals are kept; or (3) quarantined for one year. Those under (2) which do not react on second test and

those under (3) which do not develop clinical symptoms within a year, may be released. Cases which show such symptoms must be killed at once.

It is my opinion that the circular of "Rules and Suggestions Concerning Glanders-Farcy" should be modified. I have made some suggested alterations, which may at least serve as a basis for discussion.

Stock letter "E" has been very useful, but I would suggest that it be modified.

The blank "Notice to Isolate Animals Having Infectious Diseases" has already been submitted to Dr. Bracken, and reads as per attached copy.

The blank "Notice to Destroy" and the blank for recording result of mallein test can both be materially improved. (See attached copies.)

RULES AND SUGGESTIONS CONCERNING GLANDERS-FARCY.

RULES.

All horses, mules and donkeys must be included in this preliminary quarantine that are discharging from the nose, or that have had recent sores upon the body, and all others that have worked as mates with such diseased animals.

The glanders placard must be posted in a conspicuous place immediately after a positive diagnosis of glanders has been made.

Test with mallein all horses, mules and donkeys that have been exposed in the stable to cases that may be reasonably suspected of having glanders-farcy.

The following must be destroyed without delay: All horses, mules and donkeys which show positive symptoms of the disease, with or without mallein reaction; all such animals that have given one clear reaction on mallein test and show any of the recognized external symptoms of the disease or any chronic lung trouble.

Horses, mules or donkeys which have reacted but show no other symptoms of the disease may either be (1) killed at once, or (2) quarantined for retest, the quarantine period to be not shorter than 30 days nor longer than one year, the retesting to be done by the local board of health; or (3) quarantined for one year. Any such quarantined animals which fail to react on second test, or which do not develop clinical symptoms within a year, may be released from quarantine. Any of these animals which develop clinical symptoms during the period of quarantine must be promptly destroyed.

Quarantine may not be released in any case until the owner has disinfected the premises as directed by health officers.

In all cases where retests are made the second dose must be one-half larger than the first.

Carcasses must be destroyed by burning, if practical; otherwise buried under four feet of earth.

VIOLATION OF QUARANTINE DEFINED.

It shall be deemed a violation of the quarantine for any person to knowingly remove, authorize or cause to be removed, any animal quarantined on account of glanders-farcy from the farm whereon it is quarantined.

It shall be deemed a violation of quarantine for any person to knowingly cause. authorize or permit to be placed, any horses, mules or donkeys, except those legally quarantined, in any stable or enclosure that is under quarantine on account of glanders-farcy.

"An Act to Prevent the Spread of Contagious and Infectious Diseases among Domestic Animals in this State." (Act of 1897.)

"Section 9.—Any person violating any provision of this act, or any rule or regulation made by the State Board of Health, or by any local board of health, or any order made by any such board under the authority hereof, shall be guilty of a misdemeanor and be punished by a fine of not less than twenty-five (25) or more than one hundred (100) dollars, or by imprisonment for not less than thirty (30) or more than ninety (90) days."

SUGGESTIONS.

The mallein test should be conducted as nearly as possible according to the plan given in the blanks sent out from this office. This plan for the test has been found very convenient, and it is important for the proper keeping of office records that the injection be made and the temperatures taken at uniform periods by different veterinarians.

It is most economical and usually most satisfactory to have the veterinarian who makes the examination and conducts the mallein test to finish the work at one trip.

Domestic animals affected with any infectious disease are considered by law as having no commercial value, so far as the work of boards of health is concerned.

Health officers should realize that the law imposes important duties upon them and severe penalty for neglect or refusal to perform these duties. They should impress the fact upon the owners that the law also imposes duties and penalties upon them.

Glanders-farcy is very fatal to human beings and easily communicable to them by inoculation through cuts or scratches upon the hands or face, or if the matter gets into the nose or eyes.

MINNESOTA STATE BOARD OF HEALTH.

NOTICE TO ISOLATE ANIMALS HAVING AN INFECTIOUS DISEASE.

(This part to be sent to the office of the State Board of Health.)

Always fill out as early as possible, for each outbreak, one of these blanks for reporting infectious diseases of animals, and return to Dr. H. M. Bracken, 515 Pioneer Press Building. St. Paul, Minn.

......................................190..

Given by local board of..
Notice served by...
Owner's or keeper's name and address..
Name of disease...
Animals quarantined (give name, age, color, sex etc., of each in case of horses or cattle)...
....

NOTICE TO ISOLATE ANIMALS HAVING AN INFECTIOUS DISEASE.

(This part to be retained by the Local Board of Health.)

......................................190..

Given by local board of..
Notice served by...
Owner's or keeper's name and address..
Name of disease...
Animals quarantined (give name, age, color, sex, etc., of each in case of horses or cattle)...
....

NOTICE TO ISOLATE ANIMALS SUSPECTED OF HAVING AN INFECTIOUS DISEASE.

(This part to be given to the Owner.)

Under authority of "An Act to Prevent the Spread of Contagious and Infectious Diseases among Domestic Animals in this State," approved March 12, 1897.

......................................190..

To......................................

You are hereby notified that the local board of health has reason to believe that there is now upon your premises the following animals (give name, age, color, sex, etc., of each in case of horses or cattle)...............
....
....
suffering from the disease known as..
This disease is communicable to other animals and is therefore both a nuisance and a menace to live stock interests.

You are hereby ordered to isolate said animals in accordance with the regulations herein given, and to maintain such isolation until such time as this board shall declare said animals free from said disease or shall take such other action as may seem necessary.

REGULATIONS FOR ISOLATION OF ANIMALS SUSPECTED OF HAVING AN INFECTIOUS DISEASE.

Copies of the law under which this action is taken, as also of the various circulars and regulations of the State Board of Health, will be supplied by the local health officer.

(1) After examination and receipt of notice to isolate, the owner or keeper must follow closely the instructions given by the health officer or board giving this notice.

(2) Maintain entire isolation of the suspected animal or animals until this order is withdrawn by local or State Board of Health. No other animals shall be permitted with or near suspected animals during their period of isolation. Nor may such suspected animals be allowed to feed or drink out of any box, tank, or other vessel, or from any feeding floors to which healthy animals of the same species have access.

(3) The person who is to care for the stock hereby ordered isolated shall be agreed upon by the owner and health officer or board of health, at the time of issuing this order. The person so selected is hereby ordered to be very careful about going about other animals that are liable to contract this disease. (Note.—This applies especially to hog cholera.)

(4) The local board of health shall be permitted to inspect the animals, herein ordered isolated, as often as may seem necessary until this order is countermanded.

(5) The law orders and provides penalty as follows:

"Section 2.—Any person who knows of, or has reason to suspect, the existence of any contagious or infectious disease in any domestic animal, shall forthwith give notice thereof to the local board of health of the town, village or city where such animal is kept."

"Section 9.—Any person violating any provision of this act or any rule or regulation made by the State Board of Health, or by any local board of health, or any order made by any such board under the authority hereof, shall be guilty of a misdemeanor and be punished by a fine of not less than twenty-five (25) or more than one hundred (100) dollars, or by imprisonment for not less than thirty (30) or more than ninety (90) days."

Such report may be made in person or by mail and should give the name of the owner or keeper, description of the supposed disease and locality of the animal.

By order of the local board of health of..............................

....

Chairman or Health Officer.

(This part to be retained by the local board.)

Always fill out as early as possible, for each outbreak of glanders, one of the blanks for reporting infectious diseases among animals, and return to the Minnesota State Board of Health Office.

NOTICE TO DESTROY ANIMALS HAVING GLANDERS-FARCY.

..................................189..

Given by local board of..

Notice served by...

Owner's or keeper's name and address...............................

....

Name and description of animal.....................................

....

(For the owner.)

..................................189..

To..

You are hereby notified that there are now on your premises the following animals (give name, age, color, etc.)..................................

....

suffering from glanders-farcy, which disease is contagious to man and animals. You are hereby ordered to have said animal killed within twenty-four hours after the service of this notice and to have the stables and things occupied and used by said animal disinfected in accordance with the following regulations:

REGULATIONS FOR DEALING WITH GLANDERS-FARCY.

By authority of law, chapter 233, approved March 12, 1897.

The slaughter of condemned animals, their burial and disinfection of stables, etc., as herein prescribed, must be done under the supervision of the health officer or chairman of local board.

The horses or mules hereby condemned must be killed within twenty-four hours after the service of this notice.

Each carcass must be covered with quicklime before filling in any earth, and each carcass. after slashing the hide, shall be buried so that the entire body shall be at least four feet below the surface of the ground.

Parties who handle the carcasses should be warned that the disease may be readily contracted by them and is very fatal to human beings. Such infection may occur through the mucous membranes of the eyes, nose or mouth, or through any cut or abrasion of the skin.

After disposing of the carcass, the next step is cleaning and disinfection of the stable and articles used by the condemned animals.

Remove and burn all litter, including hay in the mangers, and bedding.

Scrape the floor clean as possible, and burn the manure and dirt that may be scraped from the floor.

Close the stable tightly as possible, filling up all holes and cracks; place in the stable from one to five washtubs of boiling water, the number to be used depending on the size of stable. On stones or bricks in each tub of water place an iron kettle or old pan, then burn in each pan or kettle three pounds of ordinary sulphur that has been saturated with alcohol. All persons should go out as soon as possible and shut the door tightly, the stable to remain tightly closed for ten or twelve hours; then open up and ventilate thoroughly for twenty-four hours.

Everything that cannot be boiled should be left hanging in the stable or burned, and when the fumigation is finished such articles should be hung out in the open air and exposed to sunshine for several days.

The interior of the stable should then be treated with fresh whitewash, and lime be scattered freely over the floors.

The interior of the mangers and feed boxes must be thoroughly disinfected by boiling water.

No horses or mules may be allowed in such stables until after at least a week of continuous exposure to free ventilation and sunshine following the above prescribed disinfection.

Temporary structures, like straw sheds, etc., should be burned, and the same is true of blankets and halters that have been used by diseased animals.

By order of the local board of health.

....

Health Officer or Chairman.

BLANK FOR RECORDING TEST WITH MALLEIN.

Use one of these blanks for each animal tested. Fill out carefully all details asked for. Follow instructions on back for use of mallein. Return a complete record of all tests to the State Board of Health.

Name and address of chairman of local board of health....................
Township ....
Owner's name and address...
Name of animal tested..................Test number....................
Description of animal: Age..........Color..........Condition...........
Weight............. Breed............. Markings........................
History of infection..
....
Symptoms ....
Date of injection...............Hour 10 p. m. Dose...................c. c.

TEMPERATURES.

BEFORE INJECTION.	AFTER INJECTION.	
Date................................	Date..............................	
10 a. m..................	6 a. m...........	4 p. m...........
4 p. m..................	8 a. m...........	6 p. m...........
6 p. m..................	10 a. m...........	8 p. m...........
8 p. m..................	12 m.....................	
	2 p. m..................	

Watered at............................each day.

Before injection. After injection.

Stable temperatures (hot, cool or pleasant)..................................
Time of appearance and disappearance, shape, size and character of local swelling ....
Post-mortem record and remarks...
....
Diagnosis (to be filled by veterinarian making test).......................
....
Action taken by local board...
Signature of veterinarian who made test..................................
Address...

Hog Cholera.—Dr. Annand has made a very careful and thorough study of the hog cholera situation in southern Minnesota, making two trips over different lines of railroad across the state, stopping at suitable intervals and making careful inquiry concerning the prevalence of the disease. It is evident that the situ-

ation is the most favorable that we have ever had at this season since 1895, and I am encouraged to hope that the loss for 1900 will be comparatively light. Much depends upon the work to be done by local health officers. The writer is still firm in the opinion that hog cholera can be effectively quarantined under suitable conditions, and I am pleased to report that Dr. Annand, who has probably had better opportunities to study the hog cholera problem in the field than any man in America, shares in the opinion that individual farm quarantine is thoroughly practical.

It is very probable that there have been few outbreaks of hog cholera in Minnesota where the method of spread was not simple and easily understood if we could only get the facts.

There are two adjoining townships in one of our most southern counties where hog cholera appeared last June. The chairmen did nothing to check its spread, and the outlook became very general. Three adjoining townships received infections from these two, but infected places were quarantined and in no case did the disease spread beyond the first quarantine. The two generally infected townships reaped a disastrous harvest. This would not be so bad if they had not been a constant source of danger from adjoining townships, where the chairmen and farmers were law-abiding.

Mr. —— of Greenville township, Dakota county, assisted a friend to load a car of hogs, and during this work he was in a stock car. After finishing the work, he went home and took care of his own hogs. In about two weeks, cholera broke out in his herd, with no other cases in the vicinity, and yet he only walked around in a stock car, and some railroad shipping pens.

Mr. G. went to Shakopee, and attended a street fair. Bought seven young pigs. Took them home. In a few days these pigs were sick, and they all died. A neighbor helped Mr. G. move the pigs from the wagon in which they were brought to the sale, over into Mr. G.'s wagon. He then went home, and in about two weeks his hogs were dying with cholera.

Not very long ago a farmer living near Morgan, Redwood county, shipped in some hogs from Olmsted county, contrary to regulations of the state board of health. These imported hogs infected those previously on the place, and resulted in an outbreak of cholera.

A farmer living near Sleepy Eye sold some hogs to a buyer at that place; the hogs were placed in the shipping pens, and, contrary to the regulations of the state board of health, sold

to another farmer, who took them back to the country. These hogs were free from the disease when the first sale was made. No cholera had existed in the neighborhood from which they came. After the usual period of about two weeks, they became sick, and were dying with cholera. Result—another outbreak of cholera. It is very evident that these hogs were infected in the railroad shipping pens.

Suppose a case: Hog cholera appears in a previously uninfected district. The outbreak is confined to two or three farms. In a reasonably intelligent and law-abiding neighborhood, this outbreak can be quarantined with reasonable certainty of success, providing the chairman posts quarantine placards, visits the neighbors, gives all the information at hand concerning the nature of the disease, and urges owners whose hogs are not infected to post notice cards.

But suppose the chairman takes no interest; suppose the owner leaves carcasses of hogs unburied, after a representative of the state board of health has left his place. Dogs are numerous. Neighbors refuse to accept suggestions concerning dogs and other sources of spread; visitors pay no attention to the notice cards,—quarantine is a failure. The disease spreads rapidly, not necessarily because the plan of quarantining is wrong, but merely because of the listlessness and general uselessness of the chairman, and the stubborness and selfishness of the owner, and the indifference of neighbors. "Render unto Caesar the things that are Caesar's."

That it is possible to maintain successful farm quarantine for hog cholera has been demonstrated over and over again during the past three years. Whether individual farm quarantine is successful or not depends largely upon township supervisors and individual farmers. The mere fact that individual farm quarantine has not been entirely successful in many townships does not contradict this statement. The thing for farmers of Minnesota to do, is to let go of the common idea of medical cure and undertake an intelligent prevention. It is probable that a satisfactory vaccine will be developed in the near future, but that alone will not solve the problem by any means, or do away with the necessity of sanitary measures.

CIRCULAR OF INFORMATION FOR LOCAL HEALTH OFFICERS.

FOR QUARANTINING HOGS SUFFERING FROM ANY INFECTIOUS DISEASE.

The proper quarantine of hogs imposes no hardship upon either the owner or the hogs themselves. The chief purpose of the board of health in quarantining any suspicious disease among hogs is to protect the financial interests of the hog raisers. Valuable time is often lost before quarantine is established. This permits serious spread of the disease to take place, and makes its control much more difficult.

The disease now prevailing in different portions of the state varies in symptoms in different localities and in different herds. It may be set down as a rule, however, when any infectious (catching) disease appears among swine that it is hog cholera, modified more or less in symptoms by well-known complications.

When hogs begin to sicken and die during the prevalence of hog cholera the disease should be reported to the local health officer or chairman of the town board, and quarantine should be established at once. It is a simple matter to release quarantine, and should it be proven that the disease is not hog cholera, no harm has been done by such quarantine.

All health officers and acting health officers are therefore instructed to see that suspicious outbreaks of disease among hogs are properly quarantined.

The health officer should explain to the owner or keeper the nature and conditions of quarantine, and see that the conditions are rigidly enforced until quarantine is released.

Hog cholera is often spread by water in small streams and lakes, and for this reason hogs must not be buried near any such lake or water course.

Poultry should not be allowed access to yards or pens where hogs are confined during the hog cholera season, and pigeons and crows should be shot or otherwise frightened away because of danger that they may spread the disease.

The health officer or inspector should always wear overalls and overshoes or rubbers when going among diseased hogs. These overalls and overshoes or rubbers should always be kept a safe distance from healthy hogs and from other agents which might convey the disease.

Quarantine cards must not be removed until six months after the last hog has died or recovered, and the premises disinfected in a way satisfactory to the local board of health.

Farmers should be urged to dispose of marketable hogs for slaughter as soon as suspected hog cholera appears in a neighborhood.

After quarantine is instituted, owners may be permitted to slaughter healthy hogs and sell the dressed carcasses. This slaughtering must be done under inspection and upon the quarantined premises.

Racks and wagon boxes used for hauling such hogs must be tight and so constructed at the bottom as to prevent the scattering of manure and litter along the highway.

Racks and wagon boxes which have been used for transporting such hogs must be thoroughly disinfected as soon as the work is finished. All parts of the wagon that have come in contact with the hogs or litter must be thoroughly disinfected. Five per cent solution of crude carbolic acid in water is cheap and effective.

Neighbors, on whose farms the disease has not yet appeared, should never be allowed to help haul the hogs from infected farms, as there is great danger that the disease will be spread from farm to farm by such action.

All dogs owned in a township where hog cholera has appeared should be ordered confined to the owners' premises.

Tuberculosis Among Breeding Herds—I have already under way a plan to interest cattle breeders in the question of bovine tuberculosis, and to induce them to voluntarily have their cattle tested. This plan is, in brief, to test, free of expense, for owners who will agree to advertise on letter heads, in stock journal cards, etc., that their herds are free from tuberculosis, and that every animal is sold subject to test, or with certificate of test. Such advertising could not be done, of course, until the herds are actually free from the disease, and in some cases this may require considerable time, but when three or four prominent breeders are thus advertising, it is quite probable that other breeders will find it desirable to do likewise. In order to accomplish this it will probably be necessary to deal very generously with breeders who are willing to accept this proposition, and whose herds contain tuberculous animals. My general thought along this line is to the effect that our best plan would be to give quite a long period of time, two or three years, so that such breeders will be enabled to breed the disease out of their herds, and get rid of it without the heavy losses that would result from killing many valuable animals. It is generally recognized by well-informed veterinarians and conservative state sanitary officials, that a tuberculous cow may have considerable value as a breeder. By the general plan which I suggest, owners would be allowed to get one or more calves from each valuable cow, it being understood that the old cows, those in advanced stages of the disease, young heifers, and probably the bulls should be killed soon after re-test.

The blank order of quarantine needs some revision. Our rules concerning quarantine and slaughter of tuberculous animals should be quite materially modified, particularly in view of the work to be done in pure bred herds.

The accompanying circular, as modified, will show my suggestions along this line.

The modified rule concerning quarantine and slaughter is still open to severe criticisms. My suggested alteration will at least serve for the purpose of discussion. This is an extremely difficult problem, and merits very careful consideration.

ORDER OF QUARANTINE FOR CATTLE SUSPECTED OF BEING TUBERCULOUS.

This order to be signed by the local health officer or authorized representative of the State Board of Health, and returned promptly to the secretary of the Minnesota State Board of Health.

City or town of.................. ....190..

Description of cattle..

....

Date of test..
When quarantined..
Where quarantined...
Order of quarantine delivered to..
Cattle owned by...
Cattle in charge of...
Notice delivered or posted (date and hour)....................................
Remarks ....
Order made and signed by..

(To be delivered to owner or person in charge.)

City or town of.................. ....190..
To.......................................(owner or person in charge.)

You are hereby ordered to isolate and retain under quarantine, upon your premises, the following described cattle..............................

....

These cattle are suspected of having tuberculosis, an infectious disease under the law. You are forbidden to violate in any respect the conditions of quarantine.

You are warned of the danger of using any food product from these animals, and are forbidden to sell or otherwise dispose of any such product during quarantine.

....
Inspector.

MINNESOTA STATE BOARD OF HEALTH.

The following rules have been adopted by the Minnesota State Board of Health, and apply to animals hereby quarantined:

All cattle which show symptoms of tuberculosis must be quarantined at once and the entire herd tested with tuberculin.

The owner shall be given the option of having his cattle, which have reacted, killed under inspection or continued under quarantine for a period not exceeding three months.

All cattle which react on re-test must be continued under quarantine for a period not exceeding three years from date of second test, the exact period of quarantine to be prescribed by the State Board of Health or an authorized representative. Such cattle must be killed at the expiration of the quarantine period. Infected stables must be cleaned and disinfected thoroughly before quarantine may be released.

Cattle that have reacted under tuberculin test may be taken out of quarantine for slaughter or other purposes, only after due notice to the local health officer and upon written permission from the State Board of Health, and may be killed only in the presence of an authorized inspector of the Local or State Board of Health.

The State Board of Health will furnish the necessary tuberculin for this work, but only to local health officers or upon written request from local health officers.

VIOLATION OF QUARANTINE DEFINED.

It shall be deemed a violation of quarantine for any person to knowingly remove, authorize or cause to be removed, without written permission from the State Board of Health, any animal quarantined on account of tuberculosis, from the building, place or enclosure wherein it was quarantined.

It shall be deemed a violation of quarantine for any person to knowingly place, cause or authorize to be placed, without written permission from the State Board of Health, any animal or animals subject to tuberculosis, in the building, place or inclosure where animals are quarantined on account of said disease.

It shall also be deemed a violation of quarantine for any person to knowingly dispose of, authorize or cause to be disposed of, any butter, meat, milk or other product, from cattle in quarantine.

An Act to prevent the spread of contagious and infectious diseases of domestic animals in this state. (Act of 1897.)

"Section 9. Any person violating any provision of this act or any rule or regulation made by the State Board of Health, or by any local board of health or any order made by any such board under the authority thereof, shall be guilty of a misdemeanor and be punished by a fine of not less than twenty-five (25) or more than one hundred (100) dollars, or by imprisonment for not less than thirty (30) or more than ninety (90) days."

The blanks for reporting infectious diseases, and the one for recording tuberculin test, also need some slight revision (see blanks accompanying).

Office Record No..............

BLANK FOR RECORDING TEST WITH TUBERCULIN.

Use one of these blanks for each animal tested. Fill out carefully all details asked for in these blanks. Follow instructions on back for use of tuberculin. These blanks are for the local health officer or owner; the large blank for the State Board of Health.

Name and P. O. address of chairman of local board of health...............
....
Owner's name and address...
Name and number of animal tested...
Description of animal: Age......Sex......Color......Condition...........
Weight........ Breed........ Markings......................................
History of infection...
....
Symptoms '..
Date of injection...............Hour 10 p. m. Dose.................c. c.

TEMPERATURES.

DAY OF INJECTION.	DAY AFTER INJECTION.	
Date	Date	
8 a. m....................	6 a. m............	4 p. m............
10 a. m....................	8 a. m............	6 p. m............
4 p. m....................	10 a. m............	8 p. m............
6 p. m....................	12 m...............	10 p. m...........
8 p. m....................	2 p. m............	

Watered at..................................each day.

Day of injection. Day after injection.

Stable temperatures (hot, cool or pleasant)................|................
Diagnosis (non-tuberculous, suspicious or tuberculous).....................
Post-mortem record or remarks..
....
Action taken by local board..
Signature of veterinarian who made test..........................
Address..

(Please fill out and return at once.)

Office Record No..............

BLANK FOR REPORTING INFECTIOUS DISEASES AMONG ANIMALS.

This form is to be used by health officers and by chairmen of local boards of health in reporting to the State Board of Health the existence of any infectious disease among animals within their jurisdiction.

Date.....................................
County of......................... Township of.........................
Name and P. O. address of local health officer.............................
Name and address of person making this report..............................
....
Owner's name and address...
Number of animals that have been exposed to infection......................
Number of animals of this kind on the farm.................................
Number and kind of animals sick..
Name of the disease from which the animal or animals are suffering.........
....

Prominent symptoms present..
....
History of infection..
....
What action has the local board taken...
....

The blank for reporting inspection of slaughtered animals can be made a very useful one, and I would suggest the alterations as shown by attached copy.

REPORT OF INSPECTION OF SLAUGHTERED ANIMALS.

City or town of..........................Date..........................

On the....................day of.........................I inspected carcasses of quarantined domestic animals as follows:

Owner's name..
Owner's address...
Within or without the city limits......................................
Cattle, number......................., Tag Nos...........................
Sheep............................., Swine..............................
I found the following animals to be diseased:
Cattle, tag Nos...
Sheep............................., Swine..............................
Killed at the slaughter house of.......................................
Killed on the private premises of......................................
Disposed of as follows:...
....
....
....
Remarks: ....
....
....
....
....
Inspector.

Make a separate return for each slaughter house. Report promptly in duplicate after each inspection to the veterinary department of the State Board of Health.

Sheep Scab—I have had considerable correspondence with Dr. Salmon, chief of the bureau of animal industry, concerning sheep scab in Minnesota. The result of this correspondence has been a very happy co-operation between the government authorities and the state board of health. Dr. Kethcem, inspector at

South St. Paul, has made trips to several portions of the state for the purpose of investigating the history of outbreaks which have been reported to Washington. All outbreaks which have been reported to this office have been carefully investigated by Dr. Brimhall, and are given elsewhere in this report. Our investigations developed the very pleasing fact that the outbreaks were all due to importations from western states. Active intervention of the bureau of animal industry, preventing interstate traffic of this kind, will prove very beneficial to Minnesota. It is of the utmost importance that sheep scab should not be allowed to spread widely in this state. Native sheep are quite free from this disease, and it is to be hoped that this happy condition may be continued.

UNSATISFACTORY FEATURES OF THE WORK.

There are still two points wherein our work with infectious diseases of animals continues unsatisfactory. I refer to the tuberculin work done by St. Paul, and the work with glanders, in both Minneapolis and St. Paul. Minneapolis work with tuberculosis seems to be very satisfactory. Re-tests are made promptly, and reports are mailed promptly to the state board. Our quarantine inspector, Mr. Pomplun, is enabled to do his Minneapolis work rapidly and effectively. The work in St. Paul is not so satisfactory. Re-testing has not been done in many cases until long overdue, and quite a number of quarantined cattle have been killed, with or without inspection, but proper reports have not been made to the state board of health. I am pleased, however, to say that reports of such inspections have been made more promptly and fully during the past month, and this feature of the difficulty may hereafter disappear.

There is reason to supose that many cases of glanders appear in both of these cities, which are killed without being reported to the state board of health; in fact, in the city of Minneapolis, their own reports specify numbers of horses which have been killed for glanders, which numbers are several times larger than the state board of health records indicate. It has been very rare indeed to receive a report of glanders from St. Paul, although there must be many cases of glanders in any city of its size. In order to specify more clearly that the difficulties found in the work with glanders in these two cities have been two:

First, the difficulty of securing reports, although this is specifically ordered in section 2 of our law dealing with infectious diseases of animals.

Second, in having the rules of the state board of health enforced, which insist that all exposed horses shall be tested.

We continue having outbreaks of glanders in the extreme western counties, and it is undoubtedly due to the presence of western range horses, which are brought into these counties for sale, or which pass through these counties to various shipping points. It is apparent that this difficulty can be obviated only by co-operation with state authorities of the two Dakotas, and with the bureau of animal industry.

GENERAL PAMPHLET.

I wish to renew a recommendation made in a previous report, that this board publish a small pamphlet containing all the rules, blanks, circulars, together with reduced copies of the large blanks now used in the veterinary work, and that these pamphlets be distributed freely among local health officers. Actual experience demonstrates that local health officers are very apt to lose copies of our rules, circulars, etc., which are sent them. A pamphlet would be better preserved, and would, in most cases, be kept in a convenient place for reference. Local health officers would then be much better informed concerning their duties and methods.

AMERICAN VETERINARY MEDICAL ASSOCIATION, 1900.

It was my privilege to attend the recent meeting of this association in Detroit. The work of veterinary state sanitary medicine occupied a very prominent place at this meeting. A number of interesting and valuable papers were presented, notably "Sarcoptic Scabies of the Horse and Psoroptic Scabies of Cattle in Montana;" "The Rapid Diagnosis of Rabies;" "The Relation of Lymphatics to Meat Inspection;" "Rabies and Hydrophobia;" "Obstacles to Enforcing Regulations Requiring the Tuberculin Test in Interstate Cattle Traffic;" "Experimental Tuberculosis, Human and Bovine, in Domestic Animals;" and "Gruber's Reaction in Hog Cholera."

Accompanying this report is a copy of the association report for 1900, containing these articles in full. Owing to the way in which the report was published, it did not seem practicable to secure reprints.

"Sarcoptic Scabies of the Horse and Psoroptic Scabies of Cattle in Montana," by Dr. M. E. Knowles.—Minnesota has been very fortunate thus far in having had no serious outbreak of scabies, either among horses or cattle. The Montana experience, as detailed in Dr. Knowles' paper, gives us valuable information concerning this disease, and also gives us the suggestion that we should be very careful about permitting outbreaks to spread, in case the disease appears. We are especially liable to have trouble from this source in the western counties, where range horses are brought into the state.

"The Rapid Diagnosis of Rabies," by Doctors Ravenel and McCarthy.—This was a very interesting paper, and if the future experience of pathologists agrees with their conclusions, a very important point has been gained for our work. Their work was undertaken mainly for the purpose of determining the comparative value of the differing methods of Babes on the one hand and Nelis and Van Gehuchten on the other, since the latter two questioned the value of the former's work and both claimed to have had positive results. The following is in part a brief abstract of a few important points presented:

Babes maintained that the most typical and characteristic lesions consist of "pericellular accumulations of embryonal cells," to which he gave the name of tubercles rabiques. The cells of the bulbar nuclei degenerate and present the various stages of chromatolysis. Nelis and Van Gehuchten consider Babes' cellular changes as secondary and of little value, and maintain that, "In the rabid animal an infiltration of leucocytes takes place in the stroma and a proliferation of the endothelial cells of the capsule takes the place of the degenerating nerve cell." The authors mention the fact that Vallee and Nocard have demonstrated that these lesions are not constant unless the disease has run its full course, being frequently absent in animals killed in early stages. Consequently the presence of these lesions would appear to justify positive diagnosis, but the absence of these lesions would not alone warrant a negative diagnosis.

The results obtained by the authors of this paper appear to sustain the claims of Nelis and Van Gehuchten, although they admit that the rabic tubercle of Babes also appears to be diagnostic of rabies. They give preference to the other method, because of its simplicity and the ease with which it can be carried out. I understand, however, that there are many competent pathologists who do not accept either as reliable or satisfactory.

"Relation of Lympathics to Meat Inspection," by Dr. Tait Butler.—This is a very thoughtful paper, in which the author gives some definite and very satisfactory information concerning the relative importance of various lympathic glands and the meaning of various changes which they show in the work of meat inspection. This work has lacked system and uniformity in the past, and has depended too much on unfounded personal opinions of those in authority.

"Rabies and Hydrophobia," by Dr. D. E. Salmon, is a very carefully prepared and very convincing argument concerning the actuality, frequency and diagnosis of rabies, followed by a study of the possibilities that lie in the line of prevention.

"Obstacles to Enforcing Tuberculin Test in Interstate Cattle Traffic."—Under this title Dr. Austin Peters of the Massachusetts Cattle Commission gave a very interesting report of the history of legislation enacted for the purpose of restricting interstate traffic in tuberculous cattle. He discusses the difficulties that have arisen in the Massachusetts work, and gives much information that should be considered by other state authorities attempting similar work. The difficulties that have appeared in the Massachusetts work are those that might be expected anywhere. We have, first of all, the expense of the work; the immense amount of it to be done; the difficulty of securing satisfactory legislation; unfairness and even dishonesty of some owners and some veterinarians; the difficulty of securing co-operation between adjoining states, and the general indifference of a public that has not yet realized the seriousness of the problem.

"Experimental Tuberculosis, Human and Bovine, in Domestic Animals," by Dr. Dinwiddie.—Dr. Dinwiddie, of the Arkansas Experiment Station, has been studying the identity and relative virulence of human and bovine tubercle bacilli for several years, and has already published some valuable articles on this subject. His conclusion supports, in the main, results already obtained by Theobald Smith and others in their studies of these same problems. Some of his points are as follows:

"First—Towards tubercle bacilli of human consumption, pigs, sheep and cattle show a susceptibility in the order named. Pigs may obtain a genuine progressive tuberculosis by infection from man, while cattle are practically insusceptible."

"Second—As regards tubercle bacilli of bovine tuberculosis, all three species are alike susceptible to the inoculation disease."

"Third—The excess of virulence of the bacilli of cattle tuberculosis over those of human consumption previously demonstrated in cattle and rabbits, holds good also for pigs and sheep,—for all susceptible animals, practically, on which the test has so far been made."

Dr. Dinwiddie concludes his article by emphasizing the influence of environment on the initiation and progress of tuberculosis in cattle and other domestic animals, as well as in the human family. Dr. Dinwiddie's paper brought out the thought that human sputum bacilli make a much more luxuriant growth on culture media than bacilli from bovine tissues. During the discussion of this article, Dr. Repp, of Iowa, brought out and emphasized the point that any study of the relative virulence of the human and bovine tubercle bacilli might be very misleading unless the bacilli could be taken from human tissues on the one hand and bovine tissues on the other, and from cases having similar histories. He thus called attention to the fact that a comparison of human sputum bacilli with bovine tissue bacilli was unscientific and possibly very misleading, especially in view of the fact previously brought out by Smith, Dinwiddie and others, that bacilli from human sputum are more saprophytic than bacilli taken from bovine tissues.

Dr. Dinwiddie also presented a paper before the United States Experiment Station Veterinary Association on "Gruber's Reaction in Hog Cholera." His experience with this reaction as a means of diagnosis has not been entirely satisfactory.

A very interesting surgical clinic was offered as a portion of each day's program. The general entertainment consisted of a day spent in Parke, Davis & Co.'s offices, laboratories and stables, and a steamboat trip on the Detroit River to Star Island.

The prominence which state sanitary work now occupies in the meetings of this association was evidenced not only by the number of papers and the amount of discussion given to subjects in this line, but even at the banquet quite a proportion of the toast subjects were on "State Sanitary Work," "Our Relations with Agriculturists," etc.

DR. BRIMHALL'S WORK.

It should be explained that Dr. Brimhall's work is necessarily irregular.

On July 12, Dr. Brimhall went to Owatonna to investigate a disease which had appeared among sheep belonging to Mr. Geo.

Miner. This gentleman had lost, during the preceding month, about forty out of a flock of 200. Post mortem examination revealed that the trouble was due to strongylus contortus (stomach worm). This disease has appeared in several places in the state during the past year, and caused considerable loss. The owner was given such information and advice as seemed necessary to prevent such losses in the future.

Dr. Brimhall next visited Rochester for the purpose of testing cattle at the state hospital for the insane, but the weather at that time was extremely warm, and the cattle not being accustomed to being tied in stables at night, it was thought best to defer the test until colder weather, as there is always a possibility of error in diagnosis under such conditions.

On July 24, went to Browerville, Todd county, to investigate a series of sudden deaths among cattle belonging to Mr. Sarff. This gentleman had lost four cattle within a short time. Upon investigation it was evident that the trouble was due to symptomatic anthrax. The animals were properly buried and brush burned over the ground where the carcasses had lain.

While at Browerville, Dr. Brimhall learned of a case of glanders among horses belonging to Mr. Reichart of Long Prairie. The symptoms and history of the case, together with the fact that strange horses were frequently put in this stable, seemed to justify a side trip to this place. Upon investigation this proved to be an unusual case of distemper.

On July 26 Dr. Brimhall went to Osakis in response to an urgent letter from an attorney, Mr. Ruggles. Upon investigation a serious glanders situation developed. It was deemed necessary to test fourteen horses in a livery stable and other horses in the neighborhood. The trouble seemed to have arisen mainly through infection from one horse which had disappeared from the neighborhood. This horse was followed up and finally located at Alexandria, and then it was learned that the horse had been secretly destroyed by the last owner. In this case it was necessary to test twenty-one horses in different stables, and kill seven. On the way over to Alexandria, Dr. Brimhall took preliminary temperatures of seven other horses in Orange township, intending to complete test next day, but was suddenly called home on account of sickness in his family. Arrangements were made for another veterinarian to finish the work.

During the next two weeks Dr. Brimhall was at home or near the two cities constantly, on account of the serious sickness to which I have just referred.

On August 16, Dr. Brimhall went to St. Cloud to investigate disease among cattle. Four had died out of a herd of sixteen; none sick at the time of visit. No subjects for post mortem. It was impossible to get material for laboratory work, but the history and symptoms pointed strongly to cerebro-spinal meningitis. Sanitary measures were suggested and arrangements made to make another visit if other cases appeared. We have heard nothing further from this outbreak.

August 22, to Sauk Center to investigate a glanders situation. There had been some local trouble in dealing with these cases, and it was thought best to have Dr. Brimhall take the matter in hand. Mr. Pangborn owned four horses at this time, two of which showed clinical symptoms. Two were killed and two others tested, but did not react. Examined a number of other horses in the city of Sauk Center, but found no symptoms of glanders.

From Sauk Center, Dr. Brimhall went to Park Rapids for the purpose of testing cattle belonging to Mr. A. A. Neil, a farmer. Mr. Neil is a very intelligent farmer who had considerable loss among his stock, but who reported the existence of suspected tuberculosis among his own cattle and seemed anxious to do what was right in the case. He was unable to obtain local veterinary assistance, and Dr. Brimhall was sent to his relief.

Beginning August 31, and continuing through fair week, Dr. Brimhall was on the fair grounds every day, watching hogs as they came in, and making frequent inspections among those on the grounds. I am pleased to report that no disease developed among the swine at the state fair.

On September 6 Dr. Brimhall went to Fergus Falls in response to a telegram which indicated that there had been a serious disease among cattle and horses belonging to Mr. Sathern at that place. Dr. Wilson accompanied Dr Brimhall on this trip. There were no sick animals at the time of visit. Upon inquiry, it was found that a neighbor had lost three cows and one horse about two months before. Mr. Sathern had lost thirteen cows, one horse and several pigs. The horse had been recently buried, but was dug up for examination. Dr. Wilson secured cultures from the blood, and the laboratory has since reported undoubted anthrax. This is interesting and quite important, because it is the first demonstrated outbreak of anthrax in the state, so far as I am aware; although it is probably not the first actual outbreak. The owner was given instructions as to disinfection and sanitary measures, to reduce as much as possible the probability of further

losses from this source. Dead animals were properly buried, stables were to be disinfected, cattle removed to stubble fields, etc.

On September 12 Dr. Brimhall went to Osakis to finish up the glanders cases in Osakis and Leslie townships, which have previously been referred to.

On September 15 he went to Fergus Falls to investigate the situation on Mr. Sathern's farm. No sick animals on hand, no new cases had appeared since previous visit.

After Dr. Brimhall returned from the Fergus Falls trip, there was an interval when work did not seem pressing, and this period was utilized in assisting us with office work, and work in the laboratory.

On September 26 Dr. Brimhall went to Aitkin, to attend to a glanders case. This horse had been under quarantine for a year on account of mallein reaction; but as it still showed no clinical symptoms, it was thought best to continue the horse under the same quarantine conditions for another year, unless clinical symptoms of the disease should sooner appear.

Among some of the more important trips made by Dr. Brimhall, were the following:

October 4, to Hugo, with Drs. Wilson and Martelle, to investigate an outbreak of supposed rabies among cattle, sheep, dogs and swine. Reported above.

October 10, St. Cloud; tested seventy-six cattle for the state reformatory. Five held for re-test.

October 19, Pine City. Serious outbreak of hog cholera. In company with Dr. E. E. Barnum, health officer, visited each infected farm and quarantined. Dr. Barnum deserves especial credit for the good work he has done under great difficulties in trying to control the spread of this disease.

October 23, Graceville, Big Stone county. Twenty horses tested for glanders; five killed, others quarantined. Went from Graceville to Beardsley in Big Stone county, to inspect rendering works. Found that the reported rendering works was merely a slaughtering house at which no rendering was done, except of material which naturally accumulated at a slaughter house.

October 31, went to Pillager, Cass county, to investigate glanders. Examined four horses and two mules; two affected with glanders, and killed. Barns ordered disinfected. From Pillager Dr. Brimhall went to Staples to re-test a horse which had been tested by Dr. Annand earlier in the season. This horse reacted

again, but being a valuable horse and showing no external symptoms, was re-quarantined.

November 9, Osakis. Re-tested two horses; one reaction. Horse killed.

November 11, Breckenridge. Tested twelve horses; six reacted; two showing external symptoms were killed; four quarantined.

November 13, Reynolds township, Todd county. Three horses killed under protest. These horses had been re-tested by a local veterinarian. Owner did not believe they were diseased, and objected to their being killed. Autopsy proved the presence of glanders.

November 18-19, with Dr. Wilson went to Forest Lake, Washington county. Visited the farm of Mr. Stromberg, who had been losing cattle from some undefined disease. Reported elsewhere.

November 28, glanders post mortem, in Hennepin county.

December 4, Owatonna; tested forty cattle for the state school. Six held for re-test.

Went from Owatonna to Rochester and tested one hundred and twenty-two cattle for the state hospital. Ten for re-test.

December 13, Marshall, Lyon county, at the request of Representative Schutz, to investigate swine disease, supposed to be hog cholera. Disease found to be undoubted hog cholera. Spread due to violation of hog cholera quarantine regulations concerning railroad shipping pens. Local health officers instructed concerning duties and best methods of dealing with the disease. Shipping pens quarantined.

December 22, Centerville and Oneka townships, in Anoka and Washington counties, to look after hog cholera outbreaks. Neither of the chairmen were aware of the outbreak, but seemed willing to do their duty.

December 27, went to St. Cloud to re-test cattle at the reformatory; one killed under inspection; the four others did not react.

Dr. Brimhall's work is necessarily somewhat more irregular than that done by either Dr. Arnand or Mr. Pomplum, and it is very difficult to make satisfactory daily reports. However, his work is so favorably known throughout the state and by the members of the state board of health, that it will not be the less appreciated on this account. We are fortunate in having for our field work in general, and especially for the difficult work of dealing with glanders, one who can do his work according to the law and rules without at the same time stirring up opposition and involving the board in lawsuits and other troubles. Those who have

not done this kind of work can hardly appreciate the difficulty of convincing most owners that their horses are affected with glanders, and should be killed. There is scarcely anything in our line of work that naturally requires more skill than the necessity of telling an owner that his horses are affected with glanders.

January 4, went to Hastings to test a herd of pure-bred cattle.

January 10 and 11, went to S. St. Paul to see to the killing of thirty-five pure-bred cattle, which had been shipped for slaughter.

January 24, went to New Brighton to investigate an outbreak of hog cholera.

February 5, went to Lanesboro to test a herd of pure-bred cattle. Mr. O'Hara changed his mind and thought he did not want the herd tested.

From there went to Preston, to Mr. Mills' place. It was impossible to test his herd that week, so went to Red Wing and tested the State School herd there.

February 13, went to Preston and tested a herd for Mr. Mills.

February 19, went to Newport to learn if possible the cause of complaint of a person whose herd had been tested by the St. Paul Health Department. Found that his cows were giving much less milk for two months after the test than they had done in previous years for those same months. He also stated that he had had twenty-five fresh cows since the test. All were doing poorly. Some ten of these were not giving over a quart and a half. The reason for this condition could not be found, as the feed and care were the best.

February 24, went to Hamilton, in Dakota county, to investigate as to the cause of death of sheep belonging to Mr. Foley. This man had a flock of thirty-six head and lost fourteen in about two weeks. Killed and made post-mortems of two, but found no marked change in any of the organs excepting one old sheep, whose liver was somewhat changed, having an increased amount of connective tissue. The heads of these two sheep and a portion of the lungs and liver were brought to the laboratory for bacteriological examination, but I believe no pathogenic organisms were found.

The owner was instructed to place the sheep in another stable where no sheep had ever been kept, also to change the feed, getting some second crop hay, and to disinfect the old stable. We have not heard from him since as to the results.

February 27, went to Owatonna to re-test six cattle at the State School. These cattle made no reactions and were released from quarantine.

Went from there to Rochester to hold post-mortem on cattle which had been held for re-test and slaughter. Seven of these cattle were butchered, and were all free from lesions, except one cow, which had a small abscess of the liver and abscess of the udder. This inflammation of the udder was probably due to the cow being dried up too suddenly. One cow died soon after re-test, and the heart was found diseased. A portion of the pericardium, lung and bronchial glands were saved in alcohol. The cause of death in this case was due to traumatic pericarditis, and not to tuberculosis, as was supposed from the report we received.

March 6, 1900, I went to Beardsley, Big Stone county, to investigate what was supposed to be an infectious disease; one man having lost four cattle and two dogs, a neighbor lost two hogs and one dog, and two other neighbors lost a dog each. A strange dog came into Mr. Benolken's yard one day, and bit his two dogs and went away. A week or so after one of these dogs was noticed biting at the cattle; soon his lower jaw became paralyzed and his tongue hung out. He was unable to drink water and died in a few days. Later one of the cows became uneasy, bellowing and chasing the dogs and pigs, and died in a few days. Three others died in the same way in about two weeks. The history was clear, except as to length of time between time of bite and first symptoms, and the trouble was undoubtedly due to hydrophobia.

The evidence being so clear it seemed unnecessary to make a bacteriological examination.

March 12, went to Worthington and examined eighteen horses and two mules just in from the range. Found one bay mare with marked symptoms of glanders, and one mare mule with slightly suspicious symptoms. These two were ordered killed, and the board referred to Dr. Reynolds for instruction as to disposal of the others. These horses were wild, and had to be caught with rope and tied up to posts in order to examine them.

Telegram—Copy.

March 13, 1900.

Dr. J. N. Gould, Worthington, Minn.:

Release horses soon as two are killed. Release car and yard soon as disinfected.

M. H. REYNOLDS.

April 17, went with Mr. Pumplun to act as one of the experts for inspecting, under protested post-mortem, a cow belonging to Mr. Hersig. The animal was slightly diseased, with tuberculosis.

April 18, went to Kimball to investigate glanders in that vicinity. Found seven cases of glanders; all were killed. Inspected thirty-six and used the mallein test in cases where it seemed advisable.

On April 24, 1900, went to Dassel to examine horses belonging to J. C. Wright, who reported the loss of three horses from some unknown disease. I found that his remaining horses were in good health, the last one having died five days before. The first horse died, as nearly as the owner could see, from the same symptoms, and those were very indefinite. All that he noticed was that they were dull, but retained their appetite.

April 25, went to Fergus Falls to re-test Ed Grass's horses. Re-tested eight. Some of these had made reactions last year, but made none this year. It was necessary to keep all together, so they were quarantined until fall, with the understanding that when I made my next trip to Breckenridge I would stop there and re-test them. If we were fortunate enough to have only one or possibly two reacting at that time, the owner would probably be willing to have them killed. Horses appeared to be in perfect health and were doing hard work.

April 27, went to Olivia to see about scabby sheep, belonging to Mr. McCorgendale. This man bought about 982 sheep from S. St. Paul early in the winter, and in from four to six weeks after getting them home they began to show symptoms of scab. All of these had been sold except eighty-two, which have had their second dipping, and are ready for market. He was instructed to keep the pens vacant for at least two months and to disinfect them, which he was very willing to do.

April 30, went to Winona to see C. W. Miller about scabby sheep. Mr. Miller bought 17,000 sheep from Wyoming last winter. The sheep were perfectly healthy and free from scab when bought, but were infected either in the cars or in Fremont, Neb., where they were unloaded to feed. They had all been sold except one, which has been dipped. Mr. Miller was instructed to keep his yards vacant for at least two months and also to disinfect them. He said that he will not take any more chances with scab, but will arrange his yards so that they will be unloaded in a small yard and put through a dipping tank before they are turned into the

general yard. He feels that he cannot afford to take chances in the future, as this experience cost him over $1,000.

May 1, went to St. Charles, Winona county, to see Mowbray & Robbins. I found the cattle isolated in a barn entirely apart from other cattle; the milk was being thrown away. Quarantine conditions were perfect. The owners had made up their mind to protest, but after looking the cattle over I found that most of them were valuable and well bred dairy cows, three of them due to calve in a few weeks. I had a long talk with the owners, who finally decided that if they could have the quarantine period extended until Aug. 23, 1900, that they would be able to get the cattle in better beef form and those that were heavy with calf would be fit for beef, they would be willing to abide by re-test, and the two suspicious ones, Nos. 3 and 9, they agreed that at the end of the quarantine period to ship all the others, and these two, if they still made an indefinite reaction, to S. St. Paul for slaughter and would waive their protest. One of the owners has taken a great interest in the test, and feels that he is competent to make the test, and said that he would be willing to do it, or they would employ some one to do it at their own expense if necessary. But I would necessarily make a trip in order to see to killing, and told them that it might be possible for me to arrange to make the re-test as I did not think that it would be policy for them to make it, although I felt that it would be honestly made.

May 2, went to Red Wing to hold autopsy on cows Nos. 142 and 140, which had reacted slightly to tuberculin test. Made a very careful and thorough post-mortem, but failed to find marked lesions of tuberculosis. The meat was passed as fit for food.

May 2, went to Cannon Falls to see about Charles Smith's scabby sheep. I found that he had purchased 1,800 sheep at Opal, Wyoming, in the winter. He has 100 left from this flock, but they have been dipped a second time and seemed to be all right. This report I got from Dr. Ketchem, as he was just taking the train, and thinking that was probably his errand down there, I had a talk with him, and he had looked after the matter, and it seemed useless for me to follow him up on the same errand.

May 15, 16 and 17, went to Manley, Rock county, to look after reported sheep scab. Found 100 sheep on farm of Mr. Pinney. They had been kept closely confined in small yard all winter. Some were troubled with an irritation of the skin caused by ticks. Others were affected by an unhealthy condition of the skin.

The owner had planned to dip them to kill the ticks, and I advised him to do so.

May 24 and 25, 1900, went to Fair Haven; examined a horse belonging to Wm. Brown. Found a case of glanders, and killed the horse, as the case was recent. The mate had been kept in separate part of the stable, and watered by himself. I did not think it necessary to test him, but ordered partial quarantine for three months.

May 31, June 1 and 2, at St. Charles. Five head of cattle belonging to Mowbray & Robbins killed, four were very slightly diseased and the meat was passed for food. The fifth had no very extensive lesions, but the disease had become generalized and the meat was condemned. There is one cow still in quarantine by special permission of Dr. Reynolds, but the owners agreed to kill her and have Dr. Eckles pass on the meat.

June 5 and 6, went to Fergus Falls to investigate cause of death among cattle on Elof Dahlberg's place. Found that on May 1, Mr. Dahlberg had seven cattle taken sick. Three died the same day they were taken sick, and the fourth died two days after. One was sick only a day and recovered; two others recovered in five or six days. The fifth was taken sick the day of my visit. This man's two adjoining neighbors also had cattle sick in the same way, but had lost none.

June 22, in company with Dr. Wilson went to Fergus Falls. Found that Mr. Ole Mantrud, who lost cattle last year from anthrax, had lost two head Wednesday night; one of these was a cow he purchased last fall and the other a young heifer which was not sick last year. He has four more head of cattle which had the disease last year and recovered.

This man did practically nothing toward disinfecting last fall. But a neighbor, who also lost cattle last year from anthrax, made a careful disinfection, and had no return this season. Dr. Wilson took samples of earth from top of graves, etc. We did not vaccinate, as all the other cattle on the Mantrud farm were probably immune, and Mr. Sathern's were free from disease.

We then drove over to Mr. Elof Dahlberg's, and learned that while he was away last Tuesday eight head of cattle died in one day. Three of these had had the disease and recovered.

DR. ANNAND'S WORK.

In compliance with an action of the executive committee, a second veterinarian has been employed especially for work with

hog cholera. Dr. Annand of Minneapolis, who served us so faithfully last season, was selected for the work, at a salary of $135.00 a month and expenses. Dr. Annand began work Aug. 23, 1899. It has not seemed best to undertake quite the same line of work as that done last year, for the reason that the present hog cholera situation differs materially from that of 1898. Instead of widespread outbreaks to deal with, covering adjoining counties, we have now to deal with isolated and widely scattered outbreaks. For this reason it has been my policy to deal with individual outbreaks, rather than institute general measures. Dr. Annand has been sent to outbreaks where there seemed the best opportunities for accomplishing material results. This necessitates considerable railroad travel, and large traveling expenses in general, but I think the expense will be justified by results. Dr. Annand is usually sent to an outbreak with instructions to stay just as long as local conditions seem to warrant, and to operate very largely on his own judgment after he sees the situation. He usually visits a given place and remains long enough to assist the local health officers in placing infected pens and yards under quarantine, and to see that the local health officers understand something concerning the nature of the disease, and their duties as health officers in connection with it. After varying periods, Dr. Annand returns to such places for the purpose of watching progress. This has a double effect of securing information concerning the disease and impressing health officers and owners with the fact that we are closely following the work. The following is a summary of Dr. Annand's work:

August 23, visited Maine Prairie township, Stearns county, badly infected last year, and from which place hog cholera had been reported this season, but found the report was an error, as there had been no recent hog cholera in that township.

August 24, went to Buffalo, Wright county. Found four farms in Buffalo township, places quarantined. Health officers to report later.

August 25, visited Kellogg, Wabasha county This was a badly infected district last year, and suspected hog cholera had been reported from there just prior to this visit. Found no hog cholera. Trouble due to improper feeding.

August 28, went to Winona. Found hog cholera had appeared in the Fourth ward. This outbreak well under control of local health officer. Source of infection, probably the stock yards, which were near the infected neighborhood.

September 1, went to Crookston, Polk county. Found a serious outbreak. Several townships mainly west of Crookston infected. Worked mostly in Crookston township; planned to return soon as we could gather more accurate information as to the extent of spread. Letters were written to the chairmen of seven townships in Polk county, and five in Red Lake county, asking for information.

(Dr. Annand went to this place again on September 29, and is there at this date, October 5).

September 4, went from Crookston to Staples, and drove twenty miles north into Cass county. Tested five horses on account of suspected glanders. Two released, two condemned, one held under quarantine.

September 11, visited Dahlgren township, Carver county. Found that hog cholera had appeared on ten farms, and that the loss had been considerable. The local board had done nothing, but the circumstances seemed to justify the opinion that, with proper action, the disease can be confined. We have since received several reports from this township, which indicates that the local health officers have been actively at work.

September 16, went to Rochester, Olmsted county. Hog cholera on three farms. The local health officers had these places all quarantined. There is reasonable prospect of preventing the further spread.

September 19, went to Marion township, Olmsted county. Hog cholera on three farms. Health officers had done nothing to prevent spread. They were given the usual instructions and the places were quarantined.

September 20, Austin, Mower county, to investigate the local situation. Found no hog cholera in that vicinity.

September 20, Spring Valley, Fillmore county. Found no hog cholera. Hog cholera had been reported as existing at the poor farm, in Canton township, Fillmore county. Dr. Annand saw Dr. McGillivray, a local veterinarian, who informed him that the disease had been confined to the poor farm, and that there was no other outbreak in the neighborhood.

September 21, went to Albert Lea to investigate the prevalence of hog cholera. Found none in that portion of the state. Freeborn county was originally one of those worst infected with the hog cholera. Inspected rendering establishments.

September 22, went to Fairmont, Martin county, to investigate local conditions. Found no hog cholera. Went from Fairmont to Welcome, Martin county, and found an outbreak in the townships of Rolling Green and Manyaska. Township officers were doing nothing to prevent the spread. Instructed chairman to quarantine and report.

(Note.—October 4.—Have just received a letter from the chairman of Manyaska township which indicates that he is at work vigorously trying to prevent further spread and loss in his township.)

September 25, St. James, Watonwan county. Found quite an outbreak in Watonwan county, especially in the townships of Nelson, Riverdale, South Bend, and St. James. Health officers had quarantined none of the infected farms. They were given the usual information, criticisms, and assistance.

(Note.—October 5.—Have just received a letter from Dr. Annand in Polk county, reporting that he has visited nine townships, and found hog cholera in four of them; also heard of hog cholera in two other townships, but had not visited them yet. The townships visited are not badly infected with the exception of one. In two townships visited, only one farm was infected in each township.)

September 29, visited Norman county, and found one infected farm in Hague township. Ordered quarantine and instructed the chairman to report at once.

October 1, went to Crookston, and the next day visited Crookston township. Found that the chairman had done nothing, although hog cholera was prevalent. Ordered quarantine, talked with the chairman concerning the disease, and methods of dealing with it, etc.

October 2, visited Andover township, and found one farm infected. Instructed the chairman as to quarantining and reporting.

October 2, visited Fairfax township. No hog cholera.

October 3, Russia township. No hog cholera.

October 4, Kertsonville township. Hog cholera general. Gave chairman usual instructions.

October 5, Red Lake Falls township. Hog cholera on three farms. Instructed chairman, etc.

October 5, Louisville township. Found hog cholera; instructed chairman to quarantine and report.

October 6, Gervais township. No hog cholera.

October 6, Terrebonne township. Hog cholera on one farm.

October 6, Lake Pleasant township. Hog cholera on two farms.

The townships in Red Lake county border on the infected townships in Polk county. Hog cholera had been in this locality for three years.

October 7, visited Reis, in Polk county. Investigated a case where several horses had been lost in this vicinity. Loss was caused by hay from land that had been flooded.

October 8, Long Prairie, Todd county, to investigate reported outbreak in that vicinity, but found none. Hotel keeper had lost some hogs from swill barrel cholera.

Reached home October 10. Local work during this week.

October 16, Plainview township; outbreak on one farm.

October 16, Watopa township; no cholera, but cholera had existed there in July.

October 17, Oakwood township; three cases of cholera. Instructed the supervisors to quarantine and report.

October 18, Whitewater township; found cholera. Supervisors had quarantined.

October 19, Elgin township; no cholera.

October 20, Hyde Park township. Cholera on four farms. Instructed supervisors to quarantine and report.

October 20, Zumbro township. No cholera.

October 21, West Albany township. No hog cholera.

October 22, visited Gilford township; found eight farms infected with cholera; chairman was doing all he could.

Oct. 23, Wilson township. Cholera on about twelve farms. Chairman working hard.

Oct. 27, Hart township. Cholera on three farms. Chairman had them quarantined.

Oct. 28, Homer township. Hog cholera on three farms. Town board had done nothing. Instructed the chairman as to his duties, etc.

Oct. 30 and 31, Eyota township. Nine farms infected, and one farm with foot rot among sheep. Went around with the chairman and Hon. A. K. Bush.

Nov. 1. Went to St. Charles, visited a farm in Saratoga township. Examined a herd of pure bred cattle. Found evidence of tuberculosis. Called on chairman and advised him to have the herd tested at once.

Nov. 1. Visited the chairman of St. Charles township and found a herd showing evidence of tuberculosis. Advised tuberculin test.

Nov. 1. Foot rot among sheep present on two farms in Dover township.

Nov. 2, Rochester. Called on the chairman of Rochester township. He had quarantined all outbreaks of cholera in that township and the disease was abating. Had visited this township earlier in the season. Nine farms infected.

Nov. 3, Marion township. Cholera had spread although the chairman of supervisors had been doing what he could to check the disease. He did not have the co-operation of his fellow farmers. Had visited this township some six weeks before.

Nov. 3, Viola township, and found cholera. Chairman of supervisors quarantined these two places.

Nov. 3, also visited Haverhill township. One infected farm. Instructed the chairman to quarantine and report.

Nov. 4, inspected rendering works in Rochester; also one place in Lewiston, Winona county.

This work was continued during November and December in the following counties: Redwood, Faribault, Brown, Scott, Dakota, Hennepin, Rice, Ramsey, Steele, and Martin, until December 6th. During this time Dr. Annand did needed work in thirty townships in these counties. I had intended to give a daily report of Dr. Annand's work for the entire quarter, but find that this would extend my report to an unreasonable length. The work during November and December was essentially the same as that reported for October. After December 9th Dr. Annand commenced making investigations and collecting evidence concerning violations of law and rules, already mentioned. This, together with some local work, occupied his time during the remainder of December, at which time his work terminated.

One of the interesting features of this work was the investigation of outbreaks in Polk and Red Lake counties. It was learned that hogs had died on a certain farm during the previous fall. Dead hogs were thrown into Red Lake River near the northern portion of Gentilly township, Polk county. This is a very sluggish stream. The outbreaks in the spring followed in series on farms near this river, and down stream the disease was carried from these farms to the surrounding country. This means that a serious outbreak had its origin when a careless farmer threw dead hogs into a sluggish stream, the previous fall. Infection for the initial outbreak was probably imported from a considerable distance, possibly from the southern portion of the state.

Dr. Annand's work has been very important, and results of great importance have been accomplished in this way. His work began this year August 22, and up to December 18, his expenses had averaged $82.90 per month, or the work cost us an average of $227.90 per month.

March 13 1900, visited Fairmont, and had Mr. Mathwig, attorney from Martin county, issue complaint against John Jepson, C. B. S. of Center Creek township, for violating the state laws in regard to quarantine. Mr. Jepson was tried before the justice court and pleaded guilty, and was fined $25 and costs. This case will probably be reported by Dr. Bracken.

May 26, visited Faribault, Rice county, to investigate an outbreak of hog cholera on State Farm for Feeble-Minded. Found hog cholera. Advised separation and other treatment. Result, no more well hogs got sick, four of the sick got better, two died and one still sick on my return trip, June 15. I staid there five days looking after this outbreak, with the above results.

June 4, went to Blue Earth City, to see county attorney, Mr. Putnam, Faribault county, in regard to prosecuting the chairmen of Verona, Prescott and Delavan townships, for last year's violations. I could not induce him to take action, he admitting that he did not know how to draw up the complaint. Returned home June 6, by way of Faribault.

June 6, visited Lake City, Wabasha county, and on the 11th went to Pepin township, and found the reported case of hog cholera on the farm of Mr. Marx, was not cholera.

June 12, visited Gilford township, Wabasha county, and found the report was false in regard to cholera.

June 13, went to Watopa township, Wabasha county. Found cholera on two farms, but well under control. Strictly quarantined. Outbreak ceased, with but little loss.

June 14, went to Winona county. Visited Dr. Staples, who spoke kindly concerning our work in that vicinity.

June 13, went to Hart township, Winona county, to the farm of Mr. Phiffer, and found the owner of hogs doing his duty, and also the chairman of supervisors living up to the letter of the law. This was a case where much complaint had been made.

June 16, visited Elba township, Winona county. There was an outbreak of cholera reported early in the year, but it had died out.

June 18, visited Plainview township, Wabasha county. There had been an outbreak on the farm of Mr. Nunimaker. There were no sick hogs at the time.

Mr. French, C. B. S., who was appointed at the last election, failed to do his duty in this case, but promised to do his duty in the future.

On the same date visited Elgin township, Winona county, and found cholera on the farm of Wm. Lyons. Saw the supervisors, who promptly quarantined and reported to the state board.

June 20, returned home.

June 21, went to Redwood Falls, Redwood county.

June 22, drove to Vesta township, and tested horses on two farms, for glanders. Killed one horse, and kept one under quarantine.

June 25, went to Walnut Grove township, Redwood county. Drove out to a place where hog cholera had previously been reported, and found no cholera at present.

June 26 and 27, tested three horses suspected of having glanders. One killed, one quarantined, one released.

June 28, went to Sleepy Eye, Brown county, but found no cholera there.

June 29, visited New Ulm, Brown county. Everything quiet.

June 30, returned home.

July 5, visited Rochester, Olmsted county. No cholera in this vicinity.

July 6, visited Kasson, Dodge county. Found no cholera.

Visited Owatonna, Steele county, and heard of cholera on the farm of Herman Borchert, Blooming Prairie township, Steele county.

July 7, visited Waseca and Mankato, but found no cholera in that vicinity.

July 9, visited Le Sueur, Le Sueur county, and Jordan in Scott county, and found no cholera.

July 10, visited Shakopee, Scott county, and Chaska, in Carver county. Found no cholera.

July 11, returned to Minneapolis, and attended the Minnesota State Veterinary Medical Assciation.

July 16, visited St. James, Watonwan county. No cholera.

July 17, visited Windom, Cottonwood county; Luverne, Rock county. No cholera.

Dr. Gould of Worthington, informed me that there was no cholera in that vicinity at the present time.

July 18, visited Pipestone, Pipestone county. Found no cholera.

July 19, visited Jackson, Jackson county, and examined a reported case of glanders, and found nothing but a nasal discharge, resulting from an ulcerated tooth.

July 20, visited Fillmore township, Martin county and Winnebago city, Faribault county. Found no cholera.

July 21, visited Wells, Faribault county, and Albert Lea, in Freeborn county, and also found no hog cholera

July 23, visited Austin, Mower county, and Spring Valley, Fillmore county. No cholera at Austin. Found three cases of cholera in Spring Valley, in Fillmore county, on the farms of Mr. Fisher, Mr. Rose of Spring Valley township, and Mr. Hamlin of Bloomfield township. Instructed supervisors of both townships what to do, and they have the cases under strict quarantine, and have notified neighbors to tie up their dogs.

July 25-28, went to Blue Earth City, Faribault county, and found cholera on the farm of Mr. Len Lane. It had also been on the farm of Mr. Wise, who had lost all his hogs. Mr. Frank lost sixteen or seventeen, but all the hogs on the farm now are healthy, and also on the farm of Mr. Guckeen. The chairman of the town board had done nothing, being newly appointed, but he will probably quarantine and report in the future.

Also found cholera in Elmore township, Faribault county, on the farms of Mr. Bowen and Mr. Sullivan. Visited the C. B. S., who claimed he did not know it until a few days before, but promised to quarantine at once.

Returned home July 28.

I find that people where hog cholera has previously existed are quite intelligent in regard to this subject, and are more careful about taking chances of its spreading when it appears in a neighborhood. There is also less cholera in the state at this time of the year that at any other time since cholera appeared in the state.

The number of townships infected during the first half of 1900	15
The number during the first quarter	4
The number during the second quarter	11

It is probable that some action should be taken by this board relative to the confinement of dogs in townships where hog cholera has appeared. This will be found a difficult problem and there is a question whether this action should be advisory or mandatory. I have suggested some alterations in our circular of information concerning hog cholera (see attached).

These suggestions may not offer an ideal solution of the problem, but may at least serve for the purpose of discussion.

Suggestions and Recommendations—I wish to call the attention of this board to the fact that hog cholera has prevailed in several townships in this state, and that the chairmen of these town boards have failed to report, although they must have known their duty and responsibility. This tendency seems to be on the increase, and it must be evident to every one at all familiar with hog cholera, that state control is entirely hopeless unless we can have reasonably prompt reports concerning outbreaks. I trust that this matter will be discussed and that we may be able to devise some means of checking this unfortunate tendency.

I would suggest the following for your consideration: That one or more chairmen who have been guilty of this offense should be arrested through the state board of health, and that we make examples of them for salutary effect on others. This cannot be done unless the state board of health takes the matter in charge and pushes the cases from the beginning. Mr. Kenning and Dr. Annand have each recently reported several instances of this kind; and I have no question but that a number of townships in this state have had outbreaks this season, but the facts have been concealed as far as possible.

MR. POMPLUN'S REPORT.

Mr. Pomplum's work as quarantine inspector is almost entirely in connection with tuberculosis; but he has been asked to look after other matters in some cases. I had expected to give a complete daily record of this work, but found that it could not have been condensed into less than five or six pages. For this reason I give a report of his work for October, which is a fair sample of the work done throughout the entire quarter until about December 20, except that during October he had an unusual proportion of work with diseases other than tuberculosis. Since December 20 Mr. Pomplum has been unable to work on account of illness.

October 17, visited P. O. Peterson's farm in Mounds View township, Ramsey county, for the purpose of investigating quarantine of certain horses at that place. Violations had been reported. Situation needs further investigation.

October 18, investigated quarantine on the Eustis farm, Mounds View township. Found quarantine being obeyed.

October 19, visited Mr. Poscheck's place, Mounds View township, to investigate report of suspicious disease among horses. Found that several horses had been affected with influenza, and

treated by Dr. Anderson of Minneapolis. Some horses had had it; had entirely recovered at the time of visit.

October 31, went to Rose township, Ramsey county, to investigate reported hog cholera. Visited several places and returned on November 2.

SUMMARY OF THE YEAR'S WORK ENDING JULY 1, 1900.

Number cattle quarantined	177
Number cattle released on second test	38
Number cattle killed	134
Cattle passed on post-mortem	67
Number cattle condemned on post-mortem	57
Number cattle sold out of quarantine	2
Number cattle held in state quarantine, Aug. 1, 1900	13

One cow taken out of owner's barn by quarantine inspector, by force, and taken to slaughter house and killed.
One cow killed under protest.
One bull sold out of quarantine; owner arrested and fined $25.00.

DETAILED REPORT FOR SIX MONTHS ENDING JULY 1, 1900.

January 10, quarantined one cow belonging to J. O. Johnson, St. Louis Park.

January 11, quarantined seven cows belonging to H. S. Miller, Golden Valley.

January 18, killed one cow belonging to J. A. Jackson, St. Louis Park; cow condemned.

January 19, quarantined five cows belonging to W. Paul at Stillwater Junction.

Also one cow belonging to John Burmister, Stillwater Junction.

January 20, quarantined one cow belonging to A. Odermatt, Rose township, and also inspected quarantine at the place of H. Schroeder at New Canada township, Ramsey county.

January 23, killed cow belonging to F. C. Moser, Dakota county. Cow passed.

January 24, quarantined seven cattle belonging to N. P. Jackson, Plymouth township, Hennepin county.

Also quarantined two cattle belonging to R. Anderson, Crystal township, Hennepin county, and arranged to kill a cow belonging to M. Luby, Golden Valley.

January 25, inspected quarantine at P. F. Kinney's, Mounds View township, Ramsey county. Arranged for killing.

January 26, killed cow belonging to P. F. Kinney; cow condemned, the disease being generalized.

January 27, killed four cows belonging to N. P. Jackson, Plymouth township. Condemned three, passed one.

Also killed one cow belonging to M. Luby, Golden Valley. Cow passed.

January 29, called at office.

Was sick and unable to work until February 20.

February 20, killed one cow belonging to Wm. Schuette, New Canada township; carcass passed.

February 21, killed one cow belonging to E. Knowlan, Rose township. Carcass condemned. Owner of animal protested against having the carcass condemned. Decision given by Dr. Reynolds, in favor of inspector.

February 22, killed one cow belonging to Wm. Jenkins, Edina township, Hennepin county. Carcass passed.

February 23, inspected quarantine at Wm. Schuette's place, New Canada township, and found that he had disposed of a bull held under state quarantine on first test.

February 24, killed one cow belonging to I. W. Gillette, of N. St. Paul. Carcass passed.

February 26, called at Dr. Reynold's office.

February 27, inspected quarantine at F. Herzig's, New Canada township; also at Matt Stranz's place at New Canada.

February 28, called at Dr. Bracken's office.

March 1, swore out warrant for Wm. Schuette, New Canada township, for violating quarantine.

March 2, inspected quarantine at Wm. Potthoff's, Woodbury township, Washington county; also inspected quarantine at F. D. Farrell's, New Canada township, where two cattle had been condemned on first test by Dr. Pomeroy. Not being placed under quarantine by Dr. Pomeroy, those two cattle were sold by Mr. Farrell to P. Pierson of Gladstone, where I followed them, and found one at Mr. Pierson's place and placed her under quarantine on the farm of P. Pierson. The other animal had been taken to S. St. Paul and killed there. No report of inspection.

March 3, killed cow belonging to Jacob Bomgard, New Canada township. Carcass passed.

March 4, killed cow belonging to P. Pierson at Gladstone, which had been sold by F. D. Farrell. Carcass passed.

March 6, quarantined three cattle at C. Holst's farm, N. St. Paul.

March 7, made trip to Hennepin county, to inspect quarantine.

March 8, arranged for a case in court against Wm. Schuette, New Canada township.

March 9, inspected quarantine at Frank Tshida's, Rose township, and arranged for killing.

March 10, attended court in case of Wm. Schuette of New Canada township, for breaking quarantine. Mr. Schuette was found guilty by the municipal court, and fined $25.00. Fine was remitted by court.

HISTORY OF THE SCHUETTE CASE.

Wm. Schuette of New Canada township, Ramsey county, owner herd tested on November 6 and 7. Place visited by Mr. Pomplun on November 24, and found that quarantine was kept, and again visited on February 23, 1900, and found that one red bull, kept under state quarantine on first test, had been sold, and sent to S. St. Paul before re-test. Sold two weeks after first test. Owner was inclined to be troublesome. Mr. Pomplun explained to him as fully as possible, the rules, etc.; that the cattle were quarantined by the state board of health; explained the quarantine regulations. The man complained that he could not understand English and Mr. Pomplun explained in German. Mr. Pomplun took special pains to explain to him, as he was expecting trouble of this kind. This man has no excuse. Threatened to do violence, etc., to whoever came to take cow out of barn. Mr. Schuette claims that Dr. Pomeroy told him that cattle could be taken out of quarantine, and taken to S. St. Paul, and slaughtered there. This is probably a mistake. At any rate, Mr. Pomplun saw Mr. Schuette after the first test, at which time he claims that Dr. Pomeroy made the statement about taking the cattle to S. St. Paul.

March 12, called at the office.

March 13, killed cow for Wm. Schuette at Swift's, S. St. Paul. Carcass condemned.

March 14, quarantined two cattle for S. Stray, Oakdale township, Washington county.

March 15, inspected quarantine at F. Herzig's, New Canada township, and arranged for killing.

March 17, inspected quarantine for Anton Odermath and Ed. Knowlan; also Mr. Wolfscher of Rose township, Ramsey county, and arranged for killing.

March 19, called at office.

March 20, killed one cow for Anton Odermatt, Rose township. Carcass passed.

On the same day, killed one cow for Frank Tshida of Rose township. Carcass passed.

March 21, killed two cows for Ed. Knowlan of Rose township. Both carcasses passed.

March 22, killed two cows for Frederick Herzig of New Canada township. Both carcasses condemned.

On the same day killed two cattle belonging to Matthew Stranz of New Canada township. One carcass passed and one condemned.

March 23, inspected quarantine in Washington county, and ordered three cattle killed. W. H. Potthoff, owner.

March 25, killed one cow belonging to A. P. Wolscher. Carcass passed.

March 26, called at office.

March 27, killed two cattle belonging to W. H. Potthoff, Woodbury township, Washington county. Two carcasses were slightly affected with the disease and were passed, and the other carcass was inspected by the government inspector, and also by the state inspector, and as there was doubt, the owner was given the benefit of the doubt, and the carcass passed.

March 28, inspected quarantine at V. Pauley's, Stillwater Junction.

March 30, quarantined one cow belonging to P. Thompson, Brooklyn township, Hennepin county, and also on same day quarantined one animal for D. F. Coveny, Brooklyn township, Hennepin county.

March 31, quarantined one animal belonging to M. Ray, Golden Valley township, Hennepin county.

On same day quarantined one animal belonging to C. Sornsen, St. Louis Park, Hennepin county.

April 2, called at office.

April 3, killed two cattle belonging to Herman Ames, Washington county. Both carcasses condemned.

April 4 and 5, inspected quarantine, Washington county.

April 6, quarantined one cow belonging to E. H. Weathrad, St. Louis Park, Hennepin county.

Same day quarantined one cow belonging to J. J. Moldestead, St. Louis Park, Hennepin county.

Same day quarantined one animal for L. A. Engell, St. Louis Park.

April 7, inspected quarantine in Hennepin county.

April 8, killed one cow belonging to Pearson, New Canada township, Ramsey county. Carcass passed.

April 9, called at office.

April 10, did not work.

April 11, went to New Brighton township, to see Frederick Herzig about killing his cow. Met him on the way going home. Mr. Herzig objects to having his cow killed. Told me if I wanted to kill the cow that I had to take her out of the barn and kill her myself.

April 12, called at Dr. Bracken's office regarding this case.

April 13, Good Friday.

April 14, went to Gladstone, New Canada township, to see Mr. Schroer, chairman of local board of health of said township, in regard to the killing of cow belonging to Frederick Herzig.

April 15, Sunday.

April 16, called at the office.

April 17, killed cow belonging to Fred Herzig. This cow was killed under protest.

April 19, ordered cow killed belonging to Geo. Scofield, Langdon, Washington county.

April 20, visited John W. Howard, Cottage Grove, and made arrangements to have his herd, ten in all, re-tested by the state.

April 21, killed cow belonging to Geo. Scofield. Carcass passed.

April 24 1900, assisted Mr. Jensen, meat inspector of St. Paul, inspecting seven cattle at the Minnesota Transfer. Six passed, and one condemned.

Cattle killed at Midway, April 24, 1900:

Bryant Bros., three; Nos. condemned tags O 179, O 112, and one animal that had an old style condemned tag not numbered. All three passed. Post-mortemed in the presence of Mr. Jensen and Dr. Kirby of the St. Paul city health department, and Mr. Pomplun and Dr. Reynolds of the state board of health.

G. Aaren Johnson, one cow; tag lost; carcass condemned. This was the only condemned cow that Mr. Johnson had, so there can be no mistake.

A. J. Johnson, three cows, O 164, O 154, O 186. All passed.

April 25, killed two cows for S. Stray, Washington county. One carcass passed, and one condemned.

April 25, killed one cow belonging to E. H. Weatherhed, Hennepin county. Carcass passed.

April 27 and 28, killed three cows belonging to V. Pauley of Stillwater Junction, Washington county. Two passed and one condemned.

May 2, quarantined one animal belonging to Nick Welch, Dakota county.

May 3, quarantined one animal belonging to Leander Weber, Dakota county.

May 4 and 5, inspected quarantine in Dakota county.

May 7, called at office.

May 8, assisted Mr. Jensen, meat inspector of St. Paul. in inspecting two cattle killed at the Minnesota Transfer.

May 9, quarantined three cattle belonging to John Horschig, Dakota county.

May 10 and 11, assisted Dr. Brimhall in testing ten cattle belonging to J. W. Howard.

May 12, inspected quarantine in Dakota county.

May 14, called at office.

May 15, quarantined one cow belonging to Henry Shields, Dakota county.

May 17, inspected quarantine at Bass Lake, Hennepin county, cattle belonging to N. P. Johnson and Robert Anderson. Ordered cows killed.

May 18, quarantined one cow for N. Bofferding, Golden Valley, Hennepin county; also quarantined one cow belonging to L. A. Anderson of same township.

May 19, quarantined one cow belonging to P. A. Graham & Son of Edina township, Hennepin county.

May 21, called at office.

May 22, killed two cattle belonging to South Side Company, which were tested on private test. Both passed.

May 23, killed three cattle belonging to N. P. Johnson, Plymouth township, Hennepin county. Condemned two, passed one. On same date killed two cattle belonging to Robt. Anderson, Crystal township. Carcass passed.

May 24, quarantined one animal belonging to C. J. Clarkson, Mendota township, Dakota county.

May 25 and 26, inspected quarantine in Hennepin county.

May 28, called at office.

May 29, inspected quarantine on C. J. Clark's place, Mendota township.

May 31, inspected quarantine on Henry Shield's place, Eagan township.

June 1, inspected quarantine at John Horschig's place, Dakota county.

June 2, inspected quarantine at Nic Welch and L. Weber's places in Mendota township.

June 4, called at office.

June 5, assisted Mr. Jensen post-mortem one cow. Carcass condemned.

June 6, quarantined one cow belonging to J. J. Murrey, Dakota county.

June 7, 8 and 9, inspected quarantine in Hennepin county.

June 11, called at office.

June 12, killed seven cattle belonging to J. W. Howard, Cottage Grove. Condemned four, passed three.

June 15, ordered cow belonging to D. F. Coveny, Brooklyn township, Hennepin county, killed. Also ordered cow belonging to P. W. Thompson of same township, killed.

June 16, ordered cow killed belonging to M. Ray of Golden Valley township.

June 19, assisted Mr. Jensen in killing two cows at the Minnesota Transfer; one passed, one condemned.

June 20, killed one cow at Golden Valley for P. Thompson, Brooklyn Center township. Cow passed.

Same date killed one cow belonging to Mr. Coveny, Brooklyn Center township. Carcass condemned.

Same date killed one cow belonging to M. Ray, Golden Valley township. Carcass passed.

June 21, called at office.

June 23, quarantined two cattle belonging to Sidney Harper, Mendota township, Dakota county.

June 25, called at office.

June 27, ordered cow belonging to L. A. Angell killed.

June 28, ordered cow killed belonging to J. J. Moldestead, St. Anthony township, Hennepin county.

June 29 and 30, quarantined five cattle belonging to Harry Partridge, St. Anthony township, Hennepin county.

SIXTY-FOUR CASES

OF

HÆMORRHAGIC SEPTICÆMIA IN CATTLE DUE TO BACILLUS BOVISEPTICUS.

WITH A REVIEW OF THE LITERATURE AND A BIBLIOGRAPHY,

BY

LOUIS B. WILSON, M. D.,
First Assistant Bacteriologist,

AND

S. D. BRIMHALL, V. M. D.,
Field Veterinarian.

FROM THE MINNESOTA STATE BOARD OF HEALTH BACTERIOLOGICAL LABORATORY AND VETERINARY DEPARTMENT.

INTRODUCTORY.*

The Minnesota State Board of Health has recently been called upon to investigate several outbreaks of a serious infectious disease of cattle, not hitherto reported as occurring in the Northwest, and with the exception of an outbreak of a similar disease near Knoxville, Tenn., reported by Fennimore,[66] in 1898, not hitherto described among cattle in North America.

The number and value of the animals affected, the invariable fatality of the disease, the possibility of its spread to other animals and other localities have made the early diagnosis and prompt handling of this, to us, new malady, matters of grave importance. Fortunately, the study of outbreak No. 1 resulted, first, through the isolation and recognition of the specific bacteria, in the diagnosis of the disease and the adoption of vigorous measures for checking its spread. A brief report of the first three outbreaks was made at the quarterly meeting of the State Board of Health, October 9, 1900, and published in the Journal of Comparative Medicine,[61] December, 1900. Subsequent outbreaks—eight in all—having given opportunity for more extensive observations, it seemed wise, in order that veterinarians might be made aware of the presence in the Northwest of haemorrhagic septicaemia in cattle, to publish at this time, the results of the work done, though it is yet incomplete in some details.

It is hoped that the publication may arouse local interest in the matter, and perhaps be the means of furnishing fresh material for further study of the etiology, pathology and prophylaxis of the disease.

*Dr. M. H. Reynolds, a member of the State Board of Health and Veterinarian to the State Agricultural Experiment Station, conducted the post mortem examinations in outbreaks, Nos. IV and VII. Aside from this and with the exceptions noted in the text, Dr. Brimhall has made the clinical observations, Doctors Brimhall and Wilson the post mortem observations, and Dr. Wilson the bacteriological observations. The latter were made in the laboratory of the Minnesota State Board of Health, and much assistance was received through the advice of Dr. F. F. Wesbrook, director of the laboratory. The literature of the disease has been reviewed and the bibliography compiled by Dr. Wilson.

HISTORY OF PREVIOUS OUTBREAKS.

Friedberger and Frohner[10] say, "This disease is not so recent as might be believed * * * The terrible epizootic described in the Veterinarian in 1858, an epizootic which decimated the bovines and wild ruminants, was nothing else than the disease in question." In 1878 Bollinger[57] described, under the name "Wild" and "Rinderseuche," an epizootic disease which killed 234 boars and 153 deer in the royal game preserves in the environs of Munich. After the plague in the parks had died out, the domestic cattle in the neighborhood began dying of the same or a very similar disease. The disease was sudden in its onset and rapidly fatal, death occurring in most cases in from 12 to 30 hours. Ninety per cent of the affected animals died. Two forms, an *exanthematous* and a *pectoral*, were described. In the former, there was a rise of temperature to 40—42 degrees C, swelling of the face and neck, stomatitis, glossitis, cyanosis and ecchymosis of the mucous membranes, and diarrhoea with blood-streaked faeces. Death occurred in from 12 to 60 hours.

In the *pectoral* form, which was not observed in cattle, there were signs of pneumonia and pleuro-pneumonia. Death resulted in from 5 to 8 days.

Post mortem, the *exanthematous* form was marked by large and small haemorrhages disseminated throughout the muscles and viscera. The intestines always showed large numbers of ecchymotic areas, while the submucous tissue was infiltrated with a serous exudate. Large haemorrhagic tumors infiltrated with serum were abundant in the subcutaneous connective tissue and penetrating the muscles. The mucous membranes of the tongue, larynx and pharynx and the lymphatic glands of these regions were swollen and infiltrated with more or less bloody serum.

In the *pectoral* form, a haemorrhagic lobular pneumonia, with considerable infiltration into the interlobular tissue of a sero-fibrinous exudate was present. The pleura was infiltrated and inflamed and covered with a fibrinous exudate. The pleural cavities contained from 2 to 25 litres of liquid. At the same time, there existed a certain degree of haemorrhagic enteritis and the widely disseminated haemorrhagic lesions common to the preceding form.

Bacteriologically, Bollinger demonstrated only that anthrax bacilli were not present, and that the disease was inoculable to cattle, horses, pigs, sheep, goats and rabbits.

In 1885, Kitt[79] studied an outbreak of an unknown epizootic disease of cattle, pigs, etc., in Simbach. He isolated a short polar-staining bacillus, non-motile, growing best aerobically in broth at incubator temperature, not liquefying gelatine, and inoculable to cattle, horses, pigs, sheep, goats, dogs and rabbits. In blood preparations collected in 1878 (consequently preserved 7 years) from the cases which had been described by Bollinger, Kitt found bacilli morphologically the same as those from the Simbach outbreak. Johne[78] confirmed Kitt's observations on material and cultures furnished him by Kitt.

Hüppe,[102] from specimens received of Kitt, also confirmed the latter's statements and identified the bacilli with (a) those shown by Semmer,[297] Perroncito,[291] Toussaint,[300] and Pasteur[289] to be the cause of European chicken cholera; (b) those described by Koch[259] and Gaffky[258] as producing septicaemia in rabbits; and (c) those Löffler and Schütz[165] had found to be the cause of schweineseuche or German swine plague. Hüppe proposed the name *B. septicaemiae haemorrhagicae* for the members of the group, and his observations and classification have been corroborated by a number of later observers.

In 1886, Oreste and Armanni[85] gave a full report, with careful bacteriological studies of a destructive disease of young buffaloes in Italy. The symptoms, pathological lesions and bacteriological findings were practically parallel throughout with those described by Bollinger and Kitt in rinderseuche.

The disease had been known, clinically, for more than a century in Italy, where in some years, it had caused the death of more than a thousand animals in a single province.

The disease recurred at certain periods of the year, (June to November) with great regularity in certain districts. Both old and young animals were affected. The first symptoms usually noticed were refusal of food, stopping of rumination, grinding of the teeth and restlessness. The temperature varied from 40 degrees to 42 degrees C.; the skin was hot and moist; the respirations were frequent and labored, with swelling of the tongue and tissues of the throat. The evolution of symptoms was very rapid, death usually occurring in from 12 to 24 hours. A very small number of the affected animals survived.

Post mortem, the tissues about the tongue and throat were found engorged with black or red blood. Numerous haemorrhagic lesions were found also, throughout the subcutaneous and intermuscular tissues. These areas frequently showed a gelatinous exudate about a haemorrhagic center.

In the blood and tissues of the animals was present a bacillus readily staining with ordinary aniline dyes, (but decolorizing by Gram's method), and showing a clear, central space, with darkly staining rounded extremities. Cultures in and on the various media, identified the organism as the same as that isolated by Kitt. The organism was shown by inoculation, to be pathogenic to buffaloes, ordinary cattle, horses, sheep, pigs, guinea pigs, rabbits, rats, chickens and pigeons. A dog was found to be quite refractory.

Poels,[89] in 1886, described a "septic pleuro-pneumonia in calves" prevalent in the vicinity of Rotterdam. The disease was markedly a septicaemic process. From the lungs, bronchial lymph glands, liver, spleen and kidneys of calves dead of the malady, coverslip preparations and cultures showed bacilli whose morphology and biology placed them in the group of *B. septicaemia haemorrhagicae.* The disease was reproduced by intrapulmonary, intratracheal and subcutaneous injections of pure cultures of the bacilli in rabbits, guinea pigs, calves, and one young steer.

In 1888, Kitt[80] described a second outbreak of haemorrhagic septicaemia in cattle occurring in Bayern.

Post mortem examinations, bacteriological studies and experimental inoculations were made, which demonstrated absolutely the nature of the disease.

Many of the cases in this outbreak were marked by haemorrhagic fibrinous pneumonia in connection with a sero-fibrinous pleuritis.

In 1889, Jensen,[77] in Jutland, described an infectious disease among calves (16 animals), which died after showing symptoms of fever and diarrhoea.

Post mortem, phlegmonous oedematous swellings were present in the subcutaneous tissue. Marked haemorrhages were present throughout all the organs. A fibrinous pleuritis, pericarditis and gastro-enteritis were present in many of the animals. The blood was well coagulated and not very dark. The spleen was swollen. In the blood and in the organs were found small, ovoidal, end-staining bacilli, which, when isolated and studied in pure cultures, were indistinguishable from those causing chicken cholera, rinderseuche, swineseuche, etc.

Rabbits and mice succumbed to injection in 48 hours; guinea pigs in 8 days. One steer died in about 30 hours after a subcutaneous injection, and showed serogelatinous,—in part haemorrhagic—infiltration of the subcutaneous and intramuscular

tissue at the point of inoculation, numerous haemorrhages in all of the organs, haemorrhagic swelling of the lymph glands and enlargement of the spleen. Chickens inoculated subcutaneously died after 11 days and showed necroses of the liver.

For the solution of the question, whether these similar diseases in various animals (rinderseuche, swineseuche, chicken cholera, etc.) are but forms of the same disease, Jensen inoculated six chickens with small doses of the bacteria of the calf disease. Four to six weeks later, the same birds were inoculated with large doses of chicken cholera bacilli, whose virulence was shown by control inoculations in chickens. The fowls previously inoculated with the "calf disease bacilli," showed no symptoms, thus apparently proving that immunity to chicken cholera in chickens had been established by vaccinal injections of *B. bovisepticus*.

Piot,[88] in 1889, reported the presence of "barbone" in the buffalo and domestic cattle of Egypt, where the disease is known as "Khounnaq," i. e. "strangles." In some villages as many as 40 per cent of all the horned cattle die in a single year. The disease appears in the wet season, and is apt to be most widespread and most virulent in the years of greatest flooding. In symptoms, pathological lesions and causative bacteria, the disease is identical with that described by Oreste and Armanni,[85] in Italy.

In 1890, Van Eecke[64] described a haemorrhagic septicaemia in horned cattle in Dutch India, particularly in Java. The lesions of the disease were parallel with those described by Bollinger.[57] The specific bacterium was isolated and studied in pure culture. Morphologically and culturally, it was identical with *B. bovisepticus.*

The bacillus was found to be very pathogenic to rabbits, mice, turtle doves, calves, horses and swine. Sheep and asses were almost immune. Guinea pigs, pigeons, chickens and goats showed general and local symptoms of the disease, but less severe than those in the first named animals. The most susceptible of all the animals were rabbits. The incubation period was 2 to 4 days. Attempts to infect calves, by way of the intestines, gave negative results.

In 1891, Galtier[69] described several cases of haemorrhagic septicaemia in oxen, imported from Algiers to Lyons.

Post mortem examinations of the animals revealed hepatization of the lungs, sub-endocardial haemorrhages and peritonitis.

The specific bacteria—resembling in all respects those of schweineseuche—were isolated from the blood and various organs.

Galtier stated that the disease was distributed among many species of large and small ruminants in Algiers.

Reischig,[92] in 1891, reported studies on haemorrhagic septicaemia in buffaloes in Hungary. The symptoms, lesions and bacteriological findings, were identical with those described by Oreste and Armanni.[85] The mortality was high, and the disease was apparently conveyed to hogs through the ingestion of material infected by the sick buffaloes.

Bongartz[58] reported, in 1892, a small outbreak among calves of a disease which he describes as the pneumonic form of rinderseuche. The heart's blood and spleen pulp contained many ovoid bacteria. Inoculated rabbits died in 24 hours, and the same bacteria were recovered from their organs.

Jakobi,[75] in 1892, studied an outbreak of the disease in cattle and swine in Germany. The first cow to die exhibited the symptoms and pathological lesions of only the pneumonic form of the disease. Eight days after exposure to the first case, four other cattle sickened and died, while yet later ten other cattle and two swine in the neighborhood likewise died of the disease. Several of the latter animals exhibited symptoms and lesions of the exanthematic form of the disease. The specific bacteria were isolated from the pleural exudate and heart's blood and shown to be identical, morphologically and culturally, with *B. bovisepticus*.

Buch,[62] in 1892, described in detail three cases of haemorrhagic septicaemia in cattle which were apparently sporadic.

The cases were at first supposed to be anthrax, but gross pathological lesions indicated that the disease was rinderseuche.

The bacteria were apparently identical with *B. bovisepticus*, as described by Kitt.[79] They were shown to be virulent to mice and rabbits.

In 1894, Janson[76] described a disease occurring near Tokio, Japan, which he thought might be "rinderseuche." Since, however, the clinical symptoms varied so greatly from those described by other observers, since "recovery was the rule," and since the bacteriological studies were very incomplete, the diagnosis may be questioned.

The disease began with chills and a temperature of 40 degrees to 42 degrees C. in cattle. The conjunctiva was darkened and swollen. The pulse and respirations were quickened. Watery mucus flowed from the nose and vagina. Abortion frequently occurred. Painful swellings of the joints, especially of the hocks, produced considerable lameness. The course of the disease was

very acute, most of the animals living but two or three days—rarely a week or more—after the onset of symptoms. Full recovery of the animals was the rule; rarely, the lameness remained for a long time, and yet more rarely death occurred.

In a study of the blood in a single case, bacteria half as long as the diameter of a red blood cell were found. They were non-motile, and in growth like the bacteria of schweineseuche.

Inoculation experiments were not made.

Sequens,[95] in 1894, reported a "buffalo and swine disease" in Hungary, which, symptomatically, was like Bollinger's wild and rinderseuche. However, since domestic cattle were not affected and since he failed to find the specific bacteria in the blood of the buffaloes, Sequens supposed that the disease was not identical with "rinderseuche." There would appear to be insufficient data for this conclusion.

In 1894, Guillebeau[71] and Hess,[72] reported an outbreak of haemorrhagic septicaemia, in which 7 cattle out of 34 in a stable showed symptoms of the disease. The 7 were slaughtered 16 to 94 hours after the beginning of the symptoms.

Post mortem fibrinous pleuritis and pericarditis, haemorrhagic infarcts of the lungs, hyperaemia of the mucous membrane of the intestine, and small haemorrhages in the mesentery and on the surface of the kidneys were present.

Sections of the lungs and direct coverslip preparations and cultures from the blood showed many bacteria, which, morphologically and culturally, belonged to Hueppe's group. The bacillus was capable of infecting the horse, dog, pig, rabbit, guinea pig and dove.

The flesh of the slaughtered animals was used for human food (!) with apparently no harmful results.

Fischer, in 1895,[67 68] described an outbreak of the exanthematic form of haemorrhagic septicaemia in Java, where the disease has the local name of "Sakit ngorok." The pectoral form of the disease is also met with in Java and is locally called "Koerang napas."

The symptoms and lesions of the two forms are identical with those described by Bollinger.[57] The specific bacteria were found to be identical, morphologically and culturally, with those described by Kitt.[79]

Von Ratz,[91] in 1896, described an acute infectious fever among buffaloes in Hungary, known locally as "barbonekrankheit." The disease was much like those forms of anthrax known as "throat or

tongue anthrax." Aside from the etiological factor, the disease was supposed to be distinguished from anthrax by the fact that it attacked buffalo, but not ordinary domestic cattle. Horses and sheep also, were not affected. On the other hand, swine which had passed unharmed through an outbreak of "schweineseuche" were attacked and died.

The disease was apparently identical with the disease previously described in Italy by Oreste and Armanni,[85] and belonged in the group of the haemorrhagic septicaemias. In one epidemic 70 per cent, in others 90 to 96 per cent of the affected animals died. Death usually occurred in 6 or 7 hours after the beginning of symptoms; rarely, it was delayed 2 or 3 days and in a few instances, 8 days.

Morphologically and culturally, the causative bacteria were identical with *B. bovisepticus.*

Inoculations of pure cultures killed horses, domestic cattle, swine, rabbits, guinea pigs, white and gray mice, ducks and pigeons in from 24 to 48 hours. Dogs and sheep, as a rule, withstood both feeding and injection experiments. Six chickens remained alive after attempted infection from a duck.

Leclainche,[81] in 1896, described a small outbreak of haemorrhagic septicaemia in cattle, in which the symptoms, lesions and bacteriological findings were identical with those described by Bollinger[57] and Kitt.[79] The bacteria were shown to be pathogenic for guinea pigs, rabbits and goats.

Sanfelice, Loi and Malato[94] reported an outbreak of "Barbone disease" in cattle and swine in Sardinia in 1897. Of 35 cattle affected, 34 died, and "a not less number of swine which were in contact with the sick cattle, also died." The symptoms and lesions were parallel with those described by Oreste and Armanni.[85]

From nasal mucus and from tissues and organs of animals dead of the disease, bacilli identical with those causing chicken cholera were isolated. With these, the disease was reproduced in rabbits, guinea pigs, one cow and one pig.

In 1898, Dr. Bosso,[59] of Turin, reported certain studies made of bacteria isolated by him from specimens from one cow dead 24 hours of haemorrhagic septicaemia.

Post mortem, the body had shown haemorrhagic spots on the perineum, swollen lymph glands, ecchymoses on the pericardium and endocardium, dark blue to black ecchymoses in the mucous membrane of the intestine, congestion of the kidneys with serous effusion, and but slightly enlarged spleen.

From the heart were obtained in coverslip preparations and in cultures, bacilli, which, morphologically and culturally, in gelatine, agar, bouillon, milk and potato, were identical with those of chicken cholera. Injections of pure cultures killed guinea pigs in 14 to 36 hours, and rabbits in 18 to 20 hours.

Histological study of sections of the myocardium, spleen and kidneys revealed the changes of ordinary coagulation necrosis in these organs.

Pease,[86] in 1898, described under the name of "Ghotwa" or "Ghotu," a specific haemorrhagic septicaemia of buffalo and cattle in British India. He says of its non-recognition and wide distribution: "In the majority of instances, any disease in which there has been fever and swelling of the limbs or body, and especially of the throat, as well as cases in which death could not be otherwise accounted for, has almost invariably been returned as anthrax. I have found that the commonest disease to be returned as anthrax is a disease named *Ghotwa*, *Gharrwa*, or *Galghotu* in the Southern Punjaub. In all the districts visited, this was reported to be a most severe and dreaded disease, and ranked next in importance to rinderpest, attacking animals apparently perfectly healthy, running its course with alarming rapidity, the animals perishing in a few hours.

"The disease is most prevalent in the rains, but may appear at other times of the year, and specially following the Christmas rains. It seems to be more prevalent in low lying land subject to periodical inundation, but is by no means confined to such spots. It attacks, most commonly, young buffaloes which are in good condition, but older animals also get it. Cattle and swine also take the disease spontaneously.

"The disease is characterized by high fever, great depression, and circumscribed swelling of the throat. The skin is dry and hot. The rectal temperature rises to 107 degrees F. or more; the pulse is frequent at the commencement, 62-80 per minute, later scarcely perceptible. There is acceleration of and great difficulty in respiration, with dilatation of the nostrils. The swellings do not crepitate on pressure. A yellow, slimy discharge from the nose is observed. The dung is often serous and fluid, red-colored and mixed with slime.

"'*Ghotwa*' often causes death in from 6 to 7 hours; in most cases it lasts for 12 to 24 hours, and seldom runs for 2 or 3 days. If it lasts longer, it may disappear and the animal recover."

"The mortality varies, but is always high, 90 to 96 per cent of deaths usually occurring. The epidemic is very sharp in summer and the mortality greater than in cold weather.

"*Post mortem*, the animals showed very numerous, large and small haemorrhagic areas disseminated throughout the body."

"The spleen was medium in size, flabby, the capsule not stretched, the pulp reddish brown.

"In the blood serum are many bacteria, which in form, size and morphology are identical with those described by Oreste and Armanni.[85]" The bacteria were further identified culturally and pathogenically as those of "Barbone" or "Rinderseuche."

"By inoculation with an artificial culture of this virus or of the blood of the buffalo suffering from the disease, we are in position to infect not only the buffalo, but likewise cattle, horses, pigs, guinea pigs, rabbits, white and gray mice and pigeons. Dogs and sheep have great resistance to the disease. Fowls and ducks are immune.(?)* Healthy rabbits kept in a room with sick buffaloes likewise took the disease and died within 24 to 48 hours."

In 1898, M. Lignieres[82] was commissioned to study the infectious diseases of cattle, horses, sheep, etc., of Argentina. He found among the cattle, especially in marshy regions, two diseases, locally known as "diarrhoea" and "enteque," which he considered as one. In the acute form, "diarrhoea," the animals die in 1 or 2 days after the onset of the symptoms of diarrhoea, pneumonia, pleurisy, etc. In the so-called "enteque" the disease sometimes lasts 3 or 4 weeks. It begins with febrile symptoms and a foetid diarrhoea. This continues until profound anaemia and death result. Apparently a "cachectic" form also exists in which gradual wasting away, with articular localizations and profound anaemia result finally in death of the animal.

In the acute form, the lesions are parallel with those originally described by Bollinger.[57] In the cachectic form, the essential lesions are found in the lungs and arteries. In the lungs, hard osseous (?)* nodules from 1 mm. to 2 cm. in diameter are found. The arteries show endarteritis with atheroma and calcerous deposits. The smaller vessels may be almost obliterated.

From the various organs of the animals affected with the different forms of the disease, Lignieres obtained a bacillus identical in all respects with the chicken cholera bacillus as described by Pasteur.

*Reviewer's Interrogation.

Should Lignieres' observations be corroborated, and the subacute and cachectic forms of the disease "enteque" shown to be due to the same bacillus as acute haemorrhagic septicaemia, a much wider field of investigation will be immediately opened. The bearing of this point on the next report herewith abstracted, will be readily appreciated.

In 1898, Dr. H. D. Fenimore[66] described, under the name "Wild and Cattle Diseases," a malady among the cattle of East Tennessee. The chronic nature of the disease, the presence of ulcers in the alimentary canal, and the somewhat incomplete bacteriological investigation, would make it appear that further careful pathological and bacteriological studies are demanded to exclude the presence of another infection or infections which may have been responsible for the modification of the symptoms and pathological lesions.

The matter is of much interest, and Dr. Fenimore's excellent article is herewith quoted at some length:

"For several years past large numbers of cattle have died in East Tennessee of a malady known as 'wild' and 'cattle disease.' It continued in its deadly course until quite a serious outbreak of it occurred in the State Experiment Station herd, when Dr. Charles W. Dabney, the president of the university, ordered it investigated. It was recognized through the assistance of Dr. Norgaard as the disease described by Bollinger in 1878 under the denomination of 'wild und rinderseuche.'

"The symptoms are loss of appetite, constipation, diminished flow of milk, increase of temperature in the early stages of the disease; after the animal gets very anaemic the temperature drops to about normal. The mucous membranes become very pale, the constipation is followed by diarrhoea, and the faeces are frequently stained with blood. The intestines are more or less distended with gas. There is a dropsical swelling hanging from between the lower jaws that preserves the imprint of the finger. This symptom, with the loose, bloody condition of the bowels, is very characteristic, and aids very much in an easy recognition of the disease. In some cases the soft parts of the head, neck, shoulders, brisket, and lower part of the legs are the seat of large oedematous swellings. The hair is bristly, and the epidermic desquamation produces an abundant furfur, and in a few cases ulcerations of the skin were noticed. In the acute form these symptoms may increase rapidly and produce death in a few days

or a week, while in a chronic form they may last for months, or even a year. From what we can ascertain, the disease takes a milder and more chronic form than in the old country, yet at any time it may assume a more virulent character.

"On *post mortem* examination the digestive mucous membrane of the fourth stomach and intestines is inflamed, swollen and dotted with ulcers. The mucous membrane from the seat of the ulcers in some cases remains attached on one side and hangs as a flap. The ulcers are particularly noticeable at the outlet of the fourth stomach, along the course of the small intestines and at the ilio-caecal valve. These ulcers are seen in various stages of development, from as large as two inches in length, and smaller ones that are in the process of repair, to cicatricial remains of where they have healed perfectly. Throughout the intestinal tract are found haemorrhages of greater or less extent, with blood-clots and a bloody liquid condition of the contents, diarrhoea being present in most cases. The lungs are at times filled with gelatinous infiltration. The pleura is inflamed, swollen, and the visceral layer adhering to that of the chest-wall. The outside of the heart shows inflammatory new growth, the pericardium is inflamed, and it, as well as the chest-cavity, contains a variable amount of dropsical liquid. Croupous lesions are found in the respiratory and intestinal tracts. The lymphatic glands are enlarged and oedematous. The subcutaneous connective tissue over the swollen parts is very much thickened and infiltrated. The abdominal cavity contains more or less liquid, and haemorrhages of the muscles and intestines are very common. All these symptoms and *post mortem* lesions were noticed in one animal, but the majority of cases seen were of the intestinal type."

The following abstracts from private letters recently received from Dr. Fenimore by the writers, contain further information:

"This disease has been giving a great deal of trouble in my practice at Knoxville, for a long time. I had called it croupous enteritis and was misled as to a true diagnosis by the chronic nature of the trouble, since Friedberger and Fröhner describe it as quite acute. I have seen cows die of it within four days from the first symptoms; then again, I have seen them live with it for two years. I suppose I have seen at Knoxville 100 cases, all of which died or were killed for autopsies. When Dr. Norgaard was sent there, I killed some cases for him and he pronounced it 'game disease,' or 'wild and rinderseuche.' One or two years later, Dr. Mohler was sent there from Washington to investigate it. I had

three cases in quarantine at the Experiment Station. We killed two of them. He took cultures, from which, however, nothing came. The third case, the lightest of the three, was allowed to live, and she apparently recovered for some months, but I saw her in September of last year (1900) and she had developed quite a bad case. It is only a matter of time when the disease will kill her. The disease is still quite prevalent in that section of country. * * * My information as to outbreaks in Virginia and Texas was from Dr. Norgaard."

Dr. Norgaard, Chief of Pathological Division United States Bureau of Animal Industry, was communicated with concerning the bacteriological findings in the Tenessee outbreak, and also in regard to the outbreaks in Texas and Virginia. The following are abstracts from his reply:

"Regarding the bacillus of haemorrhagic septicaemia which we obtained from an outbreak of 'game and cattle disease' near Knoxville, Tenn., I would say that nothing was published on this subject and that we are not in possession of cultures from this outbreak. The investigation was carried on by a member of our force (Dr. Mohler?) who is no longer with us, but I remember that the bacillus which was found in nearly pure culture in all the lesions of the affected animals, was an oval, pole-staining bacillus in most respects identical with the swine plague bacterium.

"* * * Concerning outbreaks in the states of Virginia and Texas, I would say that in place of Virginia, it should read District of Columbia, where the disease was observed among the deer and elk in the Zoölogical Garden. While in Texas in 1896, I had the privilege of observing a similar outbreak among cattle in the vicinity of Junction, Kimble County, Texas. Although I only succeeded in obtaining rather mild cases for examination, a description furnished me by intelligent stockmen of the more severe and almost invariably fatal cases left little doubt in my mind that the disease in question must be identical with or closely related to Bollinger's wild and rinderseuche. This supposition was borne out by statements to the effect that dozens of deer were found dead with similar lesions in the same neighborhood. The principal symptoms consisted in an extensive inflammatory swelling first appearing in the submaxillary region and extending from there down along the under side of the neck and into the brisket, causing death in from 2 to 7 days."

When all the facts concerning this outbreak reported by Dr. Fenimore are considered in relation to the recent studies of M. Lignières, on "diarrhoea" and "enteque" (acute and chronic haemorrhagic septicaemia of cattle) in South America, the matter becomes one of great importance. If it be true that, at least in the Western hemisphere—North and South America—the bacillus of haemorrhagic septicaemia is capable of causing not only an acute disease but also sub-acute and chronic processes, the veterinarian and pathologist must extend widely the field from which this possibly causative bacillus is to be excluded in diagnosing outbreaks of unknown diseases of the lower animals.

From the foregoing it will be seen that there is a widespread infectious disease of bovines, which has the following general characteristics: It is distributed the world over, but is apparently most common in low-lying regions and most general in wet seasons. The animals attacked are of all ages. The onset of the disease is sudden, its course rapid and its termination usually (90 to 98 per cent) fatal. Thirty to 90 per cent of all animals in an infected herd, die. The clinical symptoms are refusal of food; cessation of rumination and lactation; initially increased temperature (42 to 43 degrees C.); rapid, labored breathing; sometimes bloody discharge from nostrils, bladder and bowels; and non-crepitant swellings in the throat region, back of shoulders, or about the ankles. The most striking pathological lesions are haemorrhages from 1 millimeter to 20 centimeters in diameter, throughout the subcutaneous, submucous, subserous and intermuscular connective tissue, infiltrating the lymphatic glands and involving several or all of the internal organs. The spleen is neither enlarged nor darkened. The causative bacteria, which may be isolated from the larger haemorrhagic areas, lymph glands, heart's blood, lung, spleen, etc., have the following distinguishing characteristics:

Ovoidal bacilli, with rounded ends 0.5 to 0.8 microns in transverse diameter, and 1.0 to 1.5 microns in length; sometimes paired and sometimes in chains of 3 to 6 individuals. The bacilli in the tissues exhibit polar staining with an unstained "belt" or "middle piece." They are non-capsulated, non-spore-forming, non-Gram-staining, and non-motile. They grow best aerobically at 37 degrees C., though capable of developing anaerobically and at room temperature; prefer the depths rather than the surfaces of media; grow feebly, if at all, on potato; fail to liquify gelatin; produce acid, but no gas in glucose media; neither acid nor gas in lactose

media; and develop varying amounts of indol and phenol in peptone solution. The lesions of the disease are reproduced in cattle and other animals by inoculation of pure cultures of the organism.

It should be insisted upon that the identification of the disease in a locality in which it has not been previously described, or by veterinarians not having had previous experience therewith shall take into consideration *(a) the essential clinical symptoms; (b) the pathological lesions as observed before the onset of decomposition; and (c) the morphological and biological identification of the specific bacilli.*

The following is a tabulated list of the principal epidemics so studied and reported to date (Jan. 1, 1901):

TABLE I.

Table Showing the Principal Epidemics of Hæmorrhagic Septicæmia in Bovines due to Bacillus Bovisepticus.

Name of Observer.	References to Bibliography.	Year.	Locality.	Local or Reporter's Name of Disease.
Bollinger	57	1878	Germany	Wild und Rinderseuche.
Kitt	79	1885	Germany	Rinderseuche.
Kitt	80	1887	Germany	Septikæmia hæmorrhagica.
Poels	89	1886	Holland	Septic pleuro-pneumonia of calves.
Oreste et Armanni	85	1886	Italy	Barbone.
Jensen	77 and 77*a*	1889	Jutland	Rinderseuche.
Piot	88	1889	Egypt	Kounnaq.
Van Eecke	64 65	1890 1895	Java	Septichæmia hæmorrhagica.
Hubenet	74	1895	Java	Septichæmia hæmorrhagica.
Galtier	69	1891	France imported from Algiers	Infectious pneumo-enteritis.
Reischig	92	1891	Hungary	Maladie des buffles ou Angine Charbonneuse.
Bongartz	58	1892	Germany	Wild und Rinderseuche.
Jakobi	75	1892	Germany	Wildseuche.
Buch	62	1892	Germany	Hæmorrhagische septikæmia.
Güllebeau and Hess	71 and 72	1894	Germany	Septikæmia hæmorrhagica. Charbon Blanc.
Fischer	67–68	1895	Dutch Indies	Septichæmia hæmorrhagica.
Leclainche	81	1895	France	Pneumo-enteritis.
Von Ratz	91	1896	Hungary	Barbone-krankheit.
Sanfelice, Loi & Malato	94	1897	Sardinia	Barbone-krankheit.
Bosso	59	1898	Italy	Septicæmia hæmorrhagica.
Pease	86	1898	British India	Ghotwa or Ghotu.
Lignieres	82	1898	Argentina	Pasteurellosis Bovina. "Diarrhœa" and "Enteque."
Fenimore	66	1898	Tennessee	Wild and Cattle Disease.

In addition to the foregoing group a number of diseases of bovines have been described which, either in their symptoms or lesions or both, resemble haemorrhagic septicaemia, but which bacteriologically have not been definitely shown to be due to *bacillus bovisepticus.* In some of these bacteriological study has been but superficial or entirely neglected. In others, bacteria closely related to *B. boviscpticus* have been found by the original observers, but thought by them to differ from *B. bovisepticus* in one or more particulars. The following table indicates briefly the principal outbreaks of such disease reported to date.

TABLE II.

Table showing Principal Diseases of Bovines which, either in their Symptoms or Lesions or both, Resemble Hæmorrhagic Septicæmia but which have not been Definitely Shown to be due to Bacillus Bovisepticus.

Name Under Which Disease was Described.	Year.	Reporter.	References to Bibliography.	Locality.	Remarks.
"Anthrax"	1900	Helmer	73	Pennsylvania	Symptoms and lesions, as described, much resemble hæmorrhagic septicæmia.—Now under investigation by Pennsylvania Live Stock Sanitary Board.
"Buffelseuche"	1894	Sequens	95	Hungary	See page 13 this report.
"Cattle Disease in Jamaica"	1896	Williams	98	Jamaica	Probably chronic form of Texas fever.
"Corn-fodder Disease"	1892	Billings	55	Nebraska	Billings (55) assertion that "cornfodder disease" is due to "a motile baccillus growing rapidly at room temperature and on potato" is based on evidence apparently insufficient and unreliable. Moore's (82*a*) careful study, 12 autopsies, demonstrated no specific bacterium.—The one factor on which diagnoses of "cornstalk disease" are frequently based is that "the cattle died suddenly soon after being turned into standing cornfodder." Such diagnoses certainly demand corroboration. The animals probably die from various causes—sometimes, as in outbreaks Nos. V., VI. and VIII., this series, from hæmorrhagic septicæmia.
		Bowhill	60		
		Moore	82*a*		
		Nocard	83-84		
		Pyle	90		
		Spencer	96		
"Malignant Sore Throat"	1886	Burke	63	British India	Thought by Nocard and Leclainche (26) to have been hæmorrhagic septicæmia.
"Pneumo-enterite dei Neonati Bovini et Suini"	1884	Perroncito	87	Italy	Thought by Nocard and Leclainche (26) to have been hæmorrhagic septicæmia.
"Rinderseuche, Eine Neue"	1894	Janson	76	Japan	See page 12 this report.
"Seuchenhaftes Bluthærnen der Rinder"	1888	Reuter	93	Germany.	

It may not be out of place to give at this point a short list of the principal infective diseases of definitely known etiology, with which haemorrhagic septicaemia in cattle has been, and may readily be, confused:

Name of Disease.	Diagnostic Points.
Anthrax.	Altered condition of blood, enlarged spleen, presence of B. anthracis, etc.
Symptomatic Anthrax.	Usually localized lesion, crepitant tumor, presence of B. anthracis symptomatici.
"Pneumo-enterite septique des Veaux." Galtier, 70.)	Due to a spore-bearing bacillus—"Pneumo-bacillus septicus"—which grows rapidly on potato.
"Septicemie des Veaux." (Thomassen, 97.)	Due to typhoid-like bacilli.

It is beyond the scope of the present article to review in detail the numerous cases reported and experimental studies made by a host of observers with reference to the symptomatology, pathology and bacteriology of the various haemorrhagic septicaemias of the lower animals and of man. But the questions of the perpetuation of the specific microbe of a disease, its transmission, mode of invasion, etc., are all so interwoven with questions of its geographical distribution, pathogenesis to various animal species, etc., that a consideration of an infectious disease in any group of animals is very incomplete without some study of related diseases in other species. Hence it has been thought advisable to give herein a brief tabulated summary of diseases—related to haemorrhagic septicaemia in bovines—found in other animals, with a bliblography for facilitating their study.

In attempting to classify these diseases, it is at once apparent that while many of them, exhibiting the symptoms and lesions of haemorrhagic septicaemia in bovines, are caused by bacilli which, morphologically and culturally, cannot be distinguished from *Bacillus bovisepticus*, there are yet others, exhibiting equally similar symptoms and lesions, which are nevertheless due to bacteria differing widely, both morphologically and biologically, from *B. bovisepticus*. In addition to separating the two groups here indicated it seemed best to give in separate tables two similar groups of diseases observed in various avian species, since the similarity of symptoms and lesions of diseases of birds to those of mammals is not so apparent as between those of various species of mammals. We have then, four groups, which are given in the following tables:

TABLE III.

Table Showing Diseases of Mammals (Other than Bovines) which in Symptoms and Lesions are Hæmorrhagic Septicæmia, and which are Due to Bacilli Indistinguishable Morphologically and Culturally from Bacillus Bovisepticus.

Animals Affected.	Name Under which Disease was Described.	Reporter.	References to Bibliography.	Year.	Locality.	REMARKS.
WILD ANIMALS—						
Bears	"Wildseuche"	Mari, H., und Agareff, A	103	1898	Russia	
Deer	"Wildseuche"	Bollinger	57	1878	Germany	
		Kitt	79	1885	Germany	
		Nunn, J. A.	104	1892	England	
Elk*	"Elchwildseuche"	Bornstedt	99	1897	Prussia	
Llama*	"Wildseuche"	Mari, H., und Agareff, A	103	1898	Russia	
Swine (wild)	"Wildseuche"	Bollinger	57	1878	Germany	
Horses	"Pasteurellose equine"	Lignieres	107-108	1898-1900	Argentina	
	"Fievre typhoide"					
Swine (domestic)	Swine plague	Salmon	205	1886	United States	
	Swine plague	Smith	227-228	1891	United States	
	Schweineseuche	Löffler and Schütz	165	1885	Germany	
	Schweineseuche	Schütz	214	1886	Germany	Identical diseases.
	Pneumonie contagieuse du porc	Nocard and Leclainche	26			
Sheep**	Pneumo-enterite	Galtier	248-249	1889	France	
	Pasteurellose ovine (Lombriz)	Lignicres	250-251	1898	Argentina	
Dogs	Pasteurellose canine	Lignieres	252	1900		
Rabbits	Rabbit septicaemia	Koch	258	1878	Germany	
		Gaffky	257	1881		
		Smith	264	1887	United States	
Guinea Pigs	Septicemie cobaye	Phisalix	263	1898	France	

* For evidence of presence of disease among deer and elk in America, see abstract from private letter from Dr. Norgaard, page 19 of this report.

** One case in a sheep has been recently met with by the writers. The lesions were similar to those of hæmorrhagic septicæmia in cattle and of swine plague. The bacteria isolated from the lesions could not be distinguished morphologically or culturally from strains isolated from cattle and swine. Swine plague was present on the same farm at the time of the sheep's death, but no definite history of infection could be shown.

TABLE IV.

Table Showing Diseases of Mammals (other than Bovines) Which in Symptoms and Lesions Closely Resemble Hæmorrhagic Septicæmia, but Which are Due to Bacteria Markedly Different From Bacillus Bovisepticus.

Animals Affected.	Name Under Which Disease was Described.	Reporter.	References to Bibliography.	Year.	Locality.	Remarks.
Men		Bordoni-Uffreduzzi	49	1888		Disease due to "proteus hominis capsulatus"—a large Gram-staining capsulated bacillus.
		Banti	48	1888		Due to proteus capsulatus septicus.
		Tizzoni und Giovannini	54	1889		Due to capsulated Gram-staining bacilli.
		Babes	44	1889		Due to capsulated Gram-staining bacilli.
	Septicemie hæmorrhagique.	Babes et Oprescue	45-46	1891		Due to capsulated bacilli.
	Idiopathic purpura hæmorrhagica.	Kolb	52	1891		Due to Gram-staining (?) capsulated bacilli.
	Hæmorrhagic sepsis	von Dungern	50	1893		Due to capsulated bacilli.
		Palmidessi	53	1895		Five human beings apparently acquired disease from a sick parrot. Bacillus markedly resembled chicken cholera bacillus, though not closely enough for positive identification.
	Hæmorrhagic Septicæmia	Howard	51	1899		Due to capsulated Gram-staining bacilli.
	Hæmorrhagic Infection	Babes	47	1900		Due to bacilli closely resembling (perhaps identical with) *B. bovisepticus*.
Wild animals, seal	Septikæmie	Bosso	100	1899		
Swine (domestic)	Swine fever	Klein	159*a*	1878	England	These four diseases are due to apparently identical motile bacilli.
	Hog cholera	Salmon	205-206	1885	United States	
	Schweinpest	Löffler und Schütz	165	1885	Germany	
	Pneumo-enterite infectieuse	Cornil et Chantemesse	132-133	1887	France	
	Marseilles swine plague	Rietsch, Jobert et Martinaud		1887	Marseilles	Due to bacilli thought by Caneva (6) and Bunzl-Federn (4) to be identical with those described by Eberth and Schimmelbusch (253) as the cause of hæmorrhagic septicæmia in Ferrets. Probably only a variety of hog cholera (Nocard and Leclainche (26) page 67.)
	Schweinrothlauf (Swine erysipelas) Rouget du porc	Löffler und Schütz	165	1885	Germany	Due to minute Gram-staining bacilli identical with those causing mouse septicæmia (259).
Ferrets	Frettchenseuche	Eberth und Schimmelbusch.	253	1888	Germany	Due to small motile bacilli similar to, if not identical with, those causing hog cholera.
Guinea Pigs	Hæmorrhagic septicæmia	Weaver	265*a*	1898	United States	Due to gas producing bacillus which grows well on potato. Otherwise morphologically and culturally like *B. bovisepticus*.
Mice	Maüsenseuche	Laser	259	1892	Germany	Due to short, motile, Gram-staining bacilli.

TABLE V.

Table Showing Diseases of Birds which in Symptoms and Lesions More or Less Resemble Hæmorrhagic Septicæmia in Mammals, and which are Due to Bacilli Indistinguishable Morphologically and Culturally from Bacillus Bovisepticus.

Birds Affected.	Name under which Disease was Described.	Reporter.	References to Bibliography	Year.	Locality.	Remarks.
Chickens	Hühnerpest	Semmer	297	1878	Germany	Identical diseases.
	Tifoide nei Gallinacei	Perroncito	291	1878	Italy	
	Cholera des poules	Pasteur	289	1880	France	
	Fowl cholera	Salmon	294	1882	North Carolina	
	Fowl cholera	Higgins	272	1898	Canada	
Turkeys	Dysentery epizootique des dindes	Lucet	305	1891	France	
Grouse	Geflügelcholera bei Steinhühnern	Karlinski	307	1890	Germany	
	Geflügelcholera bei Rebhühnern	Klee	308	1898	Germany	
Pigeons	La Maladie des Palombes	Leclainche	314	1894	France	
Ducks	Cholera des Canards	Cornil	316	1888	France	
	Septicemie hæmorrhagique	Rabieaux	318-319	1900	France	
Geese and swans	Cholera	Willach	321	1895	Germany	
Canary birds	Kanariencholera	Kern	322	1896	Germany	

TABLE VI.

Table Showing Diseases of Birds which in Symptoms and Lesions Resemble Hæmorrhagic Septicæmia in Mammals, but Which are Due to Bacteria Different from *Bacillus Bovisepticus.*

Birds Affected.	Name Under Which Disease was Described.	Reporter.	References to Bibliography.	Year.	Locality.	Remarks.
Chickens......	Fowl enteritis........................	Klein.......	281-282	1889	England.............	Organisms thought by Klein to differ from European fowl cholera in morphology and pathogenesis. From his description, however, the resemblance would appear to be very close.
	Enterite Diarrheique Enzootique des Poules..............................	Lucet.......	284	1895	France...............	Organisms grow abundantly on potato and are not pathogenic for rabbits. Otherwise closely resemble those of fowl cholera.
	Septicemie la Poule	Lignieres...	282*a*	1894	France...............	Due to *bacillus coli communis.*
	Fowl cholera............................	Moore......	286	1895	United States....	"Specific bacillus is like that of European chicken cholera except that it is a trifle larger, takes the polar stain feebly, saponifies milk, does not acidify saccharose media and fails to cross-immunize (rabbits) with the European chicken cholera organism."
	Infectious leukæmia in fowls...........	Moore......	287	1896	United States....	
	Hühnerepizootic........................	Mazza......	285	1899	Italy.................	Due to a large motile bacillus which does not coagulate milk, grows well on potato, is not pathogenic for rabbits and is rarely found in the blood of affected birds.
	Septicæmia among young chickens	Rettger	293	1900	United States (Ohio)	Disease attacks only young chickens. Due to actively motile, evenly staining bacilli.
Turkeys.......	Epizoötic pneumo-pericarditis	McFadyean	306	1893	England.............	Due to Gram-staining, motile bacilli.
Grouse.........	Grouse disease.........................	Klein.......	309-312	1889	England & Scotland.	Due to motile bacilli.
	Pheasant disease.......................	Klein.......	313	1894	England & Scotland.	Due to motile colon-like bacilli.
Pigeons........	Fatal disease of Pigeons...............	Moore......	315	1895	United States........	Due to actively motile bacilli of the hog cholera group.
Swans........	Hæmorrhagische septikämie...........	Fiorentini..	317	1896	Italy.................	Due to large, motile, Gram-staining bacilli.
	Maladie des cygnes coscoroba	Tretrop	320	1900	France...............	Due to *bacillus coscoroba*—Tretrop. The organism is not pathogenic for ducks or chickens, otherwise it closely resembles the bacillus of fowl cholera.
Canary birds..	Infectiose Erkrankung der Kanarienvogel..............................	Rieck.......	323	1889	Germany............	Due to motile bacilli.

HISTORY OF MINNESOTA OUTBREAKS.

OUTBREAK NO. 1.

The first outbreak occurred on the farm of Mr. R. W. Edmundson, near Newport, Minn., beginning Aug. 17, 1900. The weather during the spring of 1900 had been hot and excessively dry. After the middle of July frequent rains fell, the temperature remaining high. The grass, which had been very short in the early summer, had begun to pick up by the middle of August. Mosquitoes, flies and other insects were becoming unusually abundant. Mr. Edmundson's cattle were originally in a hilly pasture which contained much brush and only wild grass. They obtained their water from a spring situated in a low portion of the inclosure. The soil was a black, sandy loam. After the death of the first lot of cattle the others were removed to a timothy and clover pasture. The herd of cattle consisted of 26 animals, mostly yearlings, and a few cows. No animals had been recently added to the herd. Their previous general health had been good. On August 17, 7 head of cattle were found dead by the owner. August 18 all the herd except one sick yearling were removed to another pasture. The sick animal at 9 a. m., was first noticed by the owner to be somewhat depressed, but was able to move about. At 2:30 p. m., it was found dead by the owner and Dr. Brimhall. An autopsy made at once.

Autopsy on (Edmundson) Animal No. 1.

The animal had apparently died without a struggle. It was somewhat bloated—probably post mortem. There were no external lesions—except a small healing wound on left hind leg—and no visible swellings. On removing the skin a few small haemorrhagic areas—under one-half inch in diameter—were found in the subcutaneous muscles over the ribs. A slight amount of serum was collected in the connective tissue about the haemorrhagic spots. The blood seemed normal except possibly lighter in color. The heart was apparently normal and filled with clotted blood. There were no lesions in the lungs. The spleen showed a few small haemorrhagic areas, irregular in shape and from one-eighth to one-fourth inch in diameter. The abdominal cavity contained a quantity of bloody serum in which the fibrin

coagulated rapidly on exposure to the air. A mass of yellow coagulated fibrin about one inch in diameter was suspended from the inner side of the abdominal wall immediately opposite one of the haemorrhagic areas which had been noted externally. About a handful of the same exudate was also attached to the pelvic organs. The vessels of the peritoneum covering the stomach and bowels were congested. The *stomach* and *intestines* contained many small ecchymotic areas not over one-eighth of an inch in diameter. The liver was apparently normal. The *kidneys* contained many pin-point haemorrhagic areas in the cortex visible through the capsule. The *bladder* was empty, the wall thickened and showed many small haemorrhagic areas on its exterior surface. All the above lesions of the internal organs appeared to be on their external surface only. No post mortem diagnosis was made.

A portion of affected muscle and the spleen were brought to the laboratory.

Bacteriological Examination (Edmundson) Animal No. 1.

Aug. 20, 1900 (two days after collection—kept in the meantime on ice), there was received in the laboratory from Dr. Brimhall, a portion of muscle and spleen from a calf dead of an obscure haemorrhagic disease at Newport, Minn. Direct smear preparations stained with eosin and methylene blue showed from:

Muscle.

(a) Many slightly enlarged diplococci or diplo-bacilli;

(b) Large bacilli, sometimes in chains, having rounded ends and numerous unstained spaces (probably putrefactive).

Spleen.—Same as Muscle.

Cultures were made on blood serum, glucose agar, and in plain and dextrose broth and grown both anaerobically and aerobically both at room temperature and in the incubator.

Muscle.—Aerobic.

Plain broth and Löffler's serum. Room temperature. Many large bacilli of same form as described under smears. In broth, a few of the diplobacilli (?)

Incubator.

Incubator. In broth, many diplo-bacilli and a few large putrefactive bacilli. (The latter may have been all placed in the medium by the original very heavy inoculations.) On serum, no growth.

Muscle.—Anaerobic.

Glucose broth and glucose agar. Room temperature. Same as similar cultures aerobic.

Incubator—Same as similar cultures aerobic.

Spleen.—Same as Muscle.

The small bacilli which were found in direct smear preparations and cultures from this case were about 0.6 to 0.8 microns thick and 1.0 to 1.5 microns long. The ends were rounded. The very short forms were almost impossible to distinguish from diplococci or short chains of streptococci. The longer forms were plainly bacilli and frequently in pairs or short chains. In most specimens the ends of the bacilli were intensely strained and the central portion but slightly so. Löffler's methylene blue brought out this end-staining to good advantage. The bacilli decolorized by Gram's method. They were non-motile. They were aerobic, but cultures direct from tissues would not grow abundantly on the surface of sloped serum or agar. They also grew faintly in glucose media, even when the strictest precautions were used to exclude oxygen. They grew abundantly at incubator temperature and slowly at room temperature. (Other biological characteristics, which will be given in discussing comparative cultures, see page 58, were present, which were sufficient to place this bacillus in the group of organisms causing chicken cholera, rabbit septicaemia, etc., and designated by Hueppe, "Bacillus Septicaemia Haemorrhagica." The organism is best specifically designated *Bacillus bovisepticus*.—Kruse.)

Pathogenesis.

Aug. 23, 1900, rabbit No. 379, weight, 1,420 grams, was inoculated in the left ear vein with 0.2 c. c. of the original 24-hour anaerobic culture from spleen of (Edmundson) Animal No. 1. Rabbit was found dead at 9 a. m. August 24. Autopsy at 11 a. m. Blood was fluid and light colored. No gross lesions. Direct coverslip preparations stained with eosin and methylene blue showed many short relatively thick bacilli, with broad unstained middle piece, having marked resemblance to diplococci. Cultures from the heart's blood and spleen showed the same bacteria as those found in the direct coverslip preparations.

August 24, rabbit No. 381, weight, 1,380 grams, was inoculated in the right ear vein with 0.2 c. c. of a 24-hour aerobic broth culture of the small bacillus from the spleen of (Edmundson) Animal No. 1. The rabbit was found dead at 9 a. m. Aug. 30, 1900. Brain was normal. Mucous membrane of trachea slightly congested. Lungs, normal. Two contiguous surfaces of liver showed a large whitish area having a fibrinous appearance. Within the liver substance were several abscesses. The surface of the spleen was thickly studded with fine granules; pulp, normal in color and consistency. Direct coverslip preparations showed small bacilli with unstained middle piece in heart's blood and spleen. From the liver abscess coverslip preparations showed many staphylococci.

Cultures.

Anaerobic and aerobic cultures in plain and dextrose broth showed small bacilli resembling those in direct coverslip preparations. *Staphylococcus pyogenes aureus* isolated from cultures from liver abscess.

While no diagnosis of the disease was made on the autopsy findings, the owner was sufficiently convinced that the other animals which had died had shown evidence of *blackleg*, that on August 22d he vaccinated the remainder of his herd with "Blacklegine."

Mr. Edmundson had been requested to notify the State Board of Health should any more of his animals become sick. On August 26th he sent a message that on August 23d and 24th four others had died, and that another was sick. This message was received August 27th, and Drs. Brimhall and Wilson on the same day visited the farm and made an autopsy on the body of a yearling heifer which had died 20 hours before.

Autopsy on (Edmundson) Animal No. 2.

The body had been hauled some distance from where it had died. The body was bloated and a bloody, foamy nasal discharge was present. There were no other external evidences of disease.

On removing the skin a number of haemorrhagic areas from one-quarter to one-half inch in diameter were found in the subcutaneous connective tissue and superficial muscles. The lymphatics of the neck and groin were markedly haemorrhagic. The blood was darker in color than normal. The heart was filled with clotted blood. Its walls showed numerous haemorrhagic areas throughout the muscle. The lungs showed only post mortem change. The abdominal cavity contained a large quantity of bloody serum. The spleen was slightly haemorrhagic in small areas. The pulp was darker and softer than normal (possibly due to post mortem changes.) The stomach showed a few small haemorrhagic areas which involved the entire thickness of the wall. The intestines were intensely inflamed. Large and small haemorrhagic areas involving the entire thickness of the walls were numerous. The liver showed no gross lesions. The bladder was empty. Its walls contained numerous haemorrhagic areas involving their entire thickness. Direct coverslip preparations, glucose agar and Löffler's serum cultures, swabs and tissues from (a) a haemorrhagic area over the groin, (b) cervical lymph gland, (c) heart's blood, and (d) spleen were collected and taken at once to the laboratory.

Bacteriological Examination (Edmundson) Animal, No. 2.

Direct coverslip preparations stained with eosin and methylene blue from haemorrhagic area over groin showed:

(a) Small bacilli similar to those described under (Edmundson) Animal No. 1—*B. bovisepticus.*

(b) Large bacilli, putrefactive; similar to those described under (Edmundson) Animal No. 1.

Cervical Lymph Gland.

Same bacilli as from haemorrhagic area.

Heart's Blood.

Small bacilli similar to those described in haemorrhagic area.

Spleen.

Small bacilli and large bacilli similar to those described under haemorrhagic area. In addition, numerous faintly staining, spore-bearing bacilli not to be distinguished from those of symptomatic anthrax.

Note—This animal had been vaccinated with "Blacklegine"—an attenuated spore-bearing culture of symptomatic anthrax bacilli on threads—five days before.

Cultures.—Haemorrhagic area over groin.

Aerobic. Löffler's serum and plain broth. Room temperature. A few small bacilli similar to those described under (Edmundson) Animal No. 1—*B. bovisepticus.* Many large putrefactive bacilli. Incubator: Many small bacilli like those described under (Edmundson) Animal No. 1—*B. bovisepticus.* No large putrefactive (?) bacilli were in the plain broth culture. Only a few colonies on serum.

Anaerobic. Glucose broth and glucose agar. Room temperature: Many large putrefactive (?) bacilli. Incubator: A slight growth of small bacilli like those described under Animal No. 1—*B. bovisepticus,* in glucose broth culture only.

Heart's blood. Cultures parallel to those made from haemorrhagic connective tissue gave parallel growths. No growth was obtained in the inoculated anaerobic cultures in glucose agar.

Cervical lymph gland. Cultures parallel in all respects to those made from haemorrhagic area over groin gave exactly parallel growths except that no large (putrefactive?) bacilli developed in any of the cultures.

Spleen. Cultures parallel in all respects to those made from haemorrhagic area over groin gave parallel growths, except that in addition in the incubated anaerobic cultures an abundant growth of the bacilli of symptomatic anthrax was present.

Pathogenesis.

Aug. 31, 1900, guinea pig No. 397, weight, 720 grams, was inoculated subcutaneously in right groin with 1.5 c. c. of a 36-hour anaerobic glucose broth culture of diplo- and large bacilli from spleen of (Edmundson) Animal No. 2. Sept. 1, 1900, at 9 a. m., the animal was found dead—less than 24 hours after inoculation—but not yet cold. Autopsy performed at once. Most intense oedema of entire body. Skin infiltrated so that the hairs readily stripped off. On opening the body, the whole of the tissues showed most intense oedema. The flesh was dark colored and filled with gas bubbles.

Direct coverslip preparations stained with eosin and methylene blue from site of inoculation showed numerous bacilli of symptomatic anthrax.

Cultures.

Aerobic. Site of inoculation—no growth. Spleen—small bacilli similar to those described under original from (Edmundson) Animal No. 1. Heart's blood—small bacilli similar to those described under original from (Edmundson) Animal No. 1.

Anaerobic. Site of inoculation—many bacilli of symptomatic anthrax. A few small bacilli similar to those noted above. Spleen—many bacilli of symptomatic anthrax. A few small bacilli similar to those noted above. Heart's blood—many bacilli of symptomatic anthrax. A few small bacilli similar to those noted above.

August 28th word was received that another animal was sick. This animal had been apparently well until the evening of the day before, when the owner noticed that it was sick and grew rapidly worse. Drs. Brimhall and Wilson went at once to the farm, where the animal was found lying on its side and unable to get up, 18 hours after the first symptoms. The breathing was labored. The temperature was 103.6. There was a black, tarry discharge from the bowels. A marked swelling without apparent gas formation was present in the submaxillary space. The animal's throat was cut and an autopsy made at once.

Autopsy on (Edmundson) Animal, No. 3.

On removing the skin, numerous large and small haemorrhagic areas in the subcutaneous connective tissue and superficial muscles were found. There was a marked yellow serous exudate in the sub-maxillary space and an intense haemorrhagic inflammation of the throat. The cervical lymphatics were all much swollen and haemorrhagic. The blood was light colored, but otherwise normal. The pericardium was distended with bloody serum. The heart muscle contained many large and small intensely haemorrhagic areas. The lungs contained a few small pyramidal haemorrhagic spots. The spleen was normal in size and consistency, but contained many small haemorrhagic spots. The stomach walls contained extensive haemorrhagic lesions. One of these in the third stomach involved about one-quarter of the entire wall and penetrated all the coats. The walls of the small intestine contained very numerous large and small haemorrhagic areas. Some of these were over one inch in diameter, involved all of the coats, and were almost perfectly black in color. The colon contained fewer haemorrhagic areas; but here, especially in the smaller colon and rectum, was an intense general inflammation of the mucous membrane. This enteritis was also present in lesser degree in the small intestine. The bowels contained black, tarry faecal matter and some bloody mucus in the portions nearest the stomach. The liver showed no gross lesions. The kidneys showed many minute ecchymoses, both cortical and deep. The bladder was filled with apparently normal urine. The walls showed no gross lesions.

Direct coverslip preparations. Broth and Löffler's serum cultures and portions of tissue were collected from haemorrhagic tissue from throat, cervical lymph gland, heart's blood and spleen and sent at once to the laboratory for further examination.

Bacteriological Examination of Edmundson Animal, No. 3.

Direct coverslip preparations stained with eosin and methylene blue. Haemorrhagic tissue from throat; a few small diplo-bacilli similar to those found in direct coverslip preparations and cultures in (Edmundson) Calves Nos. 1 and 2. Cervical lymph gland: Same as in haemorrhagic area on neck. Heart's blood: Same as in haemorrhagic area on neck. Spleen: Same as in haemorrhagic region on neck, and, in addition, a very few slightly staining sporebearing bacilli not to be distinguished from those of symptomatic anthrax.*

Cultures.

Aerobic. Grown only at 37 degrees C. Haemorrhagic tissue from throat. Many colonies—unmixed with other organisms—of small, polar-staining, diplo-bacilli not to be distinguished from those obtained from Animals Nos. 1 and 2. Cervical lymph gland: Same as from haemorrhagic tissue. Heart's blood: Same as haemorrhagic tissue. Spleen: Same as haemorrhagic tissue.—*B. bovisepticus.*

Anaerobic. Grown only at 37 degrees C. Exactly parallel with aerobic cultures, except that (a) the growth of the bacilli was very scant in all cultures, and (b) in addition, the bacilli of symptomatic anthrax were present in the cultures from the spleen.

Pathogenesis.

Aug. 31, 1900, guinea pig No. 396, weight, 630 grams, was inoculated subcutaneously in right groin with 1.5 c. c. of a 36-hour anaerobic glucose broth culture of the organism from spleen of (Edmundson) Animal No. 3. —*B. bovisepticus.* On September 4 the animal was found dead and partially eaten by gray rats which had made an entrance into the animal room. No autopsy was possible.

Mr. Edmundson lost another animal September 1st, from apparently the same disease. No autopsy was obtained.

Mr. Edmundson's herd consisted originally of 26 head of cattle. Of these, 15 showed symptoms of the disease and all succumbed. None lived over 24 hours after the first symptoms were observed. All animals were isolated as soon as they were observed to be sick. When dead, they were buried or burned. The ground on which the animals died was covered thickly with straw and burned over. No attempt at medical treatment was made.

*Note.—This animal had been vaccinated with "Blacklegine" at the same time and in the same manner as described under (Edmundson) animal No. 2. The finding of the spore-bearing "hadow forms" of the bacilli of symptomatic anthrax in the spleens only of these two previously vaccinated animals is of some interest. Incidentally and as was to be expected, the futility of vaccination wiht black leg virus as a protective against this disease has also been shown in this outbreak.

OUTBREAK NO. II.

The second outbreak began Aug. 21, 1900 on the farm of Mr. Joseph Arth, 5 miles west of Forest Lake, Minn., and 25 miles north of the location of the first outbreak. The cattle were in a large level woods pasture. A large portion of the enclosure consisted of oak clearing. The remainder was tamarack swamp and very wet at the time. The soil was a light sandy loam.

The herd of cattle consisted of 16 head, mostly old stock. No animals had been recently added to the herd. Their previous general health had been good.

Between Aug. 21 and Aug. 27, 1900, 4 head of cattle died. On August 28,* Drs. Brimhall and Wilson visited the farm and found a yearling heifer sick. The animal was lying down, and when first examined was able to get up, though very unwilling to do so. After rising, she walked stiffly a few steps, then lay down. The breathing was almost normal, and there were no evidences of pain. Temperature, 105.6 F. There were sensitive swellings about the digits of both legs on the left side. Another marked, though not sensitive, swelling was just behind the left shoulder. At this point, and also just in front of the shoulder, a bloody serum was exuding from the skin. There was a dark, semi-solid—though not tarry—discharge from the bowels. (This the owner had noticed in all the other animals a short time before death.)

Two hours later the breathing had become rapid and labored. A moaning noise was made with each expiration. The animal was apparently in pain, though not restless. Temperature had dropped to 104 F. She grew rapidly worse, and, when almost dead, near midnight, was killed by bleeding, and an autopsy made at once.**

Autopsy on (Arth) Animal, No. IV.

On removing the skin marked haemorrhagic lesions were found about the digits on the left side. Similar lesions in the subcutaneous tissue and superficial muscles were scattered over the entire body. They were most numerous about the shoulders, flanks and along the back. Some were two inches in diameter. Just back of the left shoulder, a yellow fibrinous exu-

*In the preliminary report at the quarterly meeting of the State Board of Health, Oct. 9, 1900, this date was erroneously stated as August 27th.

*Though this autopsy was made at night, the light—from a large "reflecting" lamp suspended over the carcass—was very good.

date, streaked with very dark coagulated blood, formed a mass varying from one-half to two inches in thickness, and from three to six inches in diameter. A recent haemorrhagic exudate infiltrated all the structures both deep and superficial about the throat. The lymphatics of this region and about the shoulder were much swollen and haemorrhagic. The tissues surrounding these were sufficiently infiltrated to obscure their size and outline when felt through the skin. The mucous membrane of the trachea was most intensely congested. The lungs contained a few small haemorrhagic points—situated sub-pleurally. The blood was light colored but otherwise apparently normal. The pericardial sac contained a quantity of bloody serum. The heart walls were intensely hæmorrhagic. The spleen was apparently normal in size and consistency, but contained a few small hæmorrhages. The diaphragm on the abdominal side contained several haemorrhagic areas. The stomach walls contained many large haemorrhagic areas. The third stomach was most affected, the entire thickness of about half its wall being involved. The appearance suggested a number of large haemorrhagic patches, later becoming confluent. The intestines contained numerous large and small haemorrhagic areas involving the entire thickness of the walls. The mesentery was similarly involved. The liver showed no gross lesions. The kidneys and bladder were apparently normal.

Coverslip preparations, swabs, cultures and tissues from the haemorrhagic area of shoulder, haemorrhagic area about pharanyx, heart's blood and spleen were collected and taken to the laboratory eight hours after the death of the animal.

Bacteriological Examination (Arth) Animal, No. 4.

Direct coverslip preparations stained with eosin and methylene blue. Haemorrhagic area over shoulder; many small bacilli not to be distinguished from those described under (Edmundson) Nos. 1 to 3, inclusive—*B. bovisepticus*. Haemorrhagic area about pharanyx: Same as haemorrhagic area over shoulder. Spleen: Same as haemorrhagic area over shoulder. Heart's blood: Same as haemorrhagic area over shoulder.

Cultures.

Anaerobic and aerobic cultures were made in plain and dextrose broth and grown both in the incubator and at room temperature. Aerobic incubated cultures gave a most abundant growth. The anaerobic incubated cultures in dextrose broth were next in development. Both anaerobic and aerobic cultures at room temperature gave only a slight growth. All of the bacteria which developed in all of the cultures appeared to be of but one variety, the small bacillus with polar-staining, and unstained middle piece, closely resembling a diplococcus, sometimes united in chains of several pairs and identical in all respects with the organism obtained from Animals Nos. 1 to 3, inclusive—*B. bovisepticus.*

August 31, guinea pig No. 399, weight, 360 grams, was inoculated subcutaneously in right groin with 1.5 c. c. of a 24-hour broth culture original from spleen of (Arth) Animal No. 4. The animal was found dead Sept. 6, 1900, and the autopsy performed at once. No apparent lesions at site of inoculation. Spleen, bright red, slightly swollen. Haemorrhagic area back of left kidney.

Direct coverslip preparations. Site of inoculation: No bacteria. Haemorrhagic area back of kidney: A few small bacilli similar to those noted from original source. Heart's blood: Same as haemorrhagic area back of kidney.

Cultures.

Only aerobic cultures were grown, and in the incubator. They showed small bacilli similar to those noted as from the original source.

Sept. 4, 1900, Drs. Brimhall and Wilson again visited Mr. Arth's farm and found a three-year-old bull dying of a disease apparently the same as that which caused the death of the animal designated as (Arth) Animal No. 4. The animal had been sicks two days and was lying on his side. There was a large oedematous swelling in the submaxillary space. Blood and froth were being discharged from the nostrils and mouth. A large quantity of clotted blood had been passed from the bowels. The animal was bled and an autopsy made at once.

Autopsy on (Arth) Animal, No. 5.

Numerous large and small haemorrhagic areas were found in the subcutaneous connective tissue about the digits and scattered over the body generally. The deep and superficial tissues about the throat were intensely congested and infiltrated with a haemorrhagic exudate. The lymphatic glands of this region were markedly enlarged and haemorrhagic. No gas was found infiltrating the tissues. The lungs showed a number of small haemorrhagic areas. The blood was a little lighter colored than normal. The pericardial sac contained a large quantity of bloody serous exudate. The heart walls were intensely haemorrhagic, especially at the apex. The spleen was normal in size and consistency, but showed a number of small haemorrhagic areas on its surface. The stomach walls contained many of these areas, ranging in size from one-eighth inch to three or four inches in diameter. The intestines and mesentery contained many large and small haemorrhagic areas scattered throughout. These areas in the stomachs and bowels extended through the entire thickness of their walls. The bowels contained dark colored liquid faeces mixed with bloody mucus. The mucous membrane was deeply congested throughout and haemorrhagic in places. The kidneys contained many small pin-point areas of haemorrhage. The bladder walls showed numerous haemorrhagic areas. The bladder contained a quantity of bloody urine, and mucous membrane was congested and haemorrhagic.

Direct coverslip preparations, swabs, cultures and tissues from the haemorrhagic area under the jaw, spleen and heart's blood were collected and taken at once to the laboratory.

Bacteriological Examination of (Arth) Animal, No. 5.

Coverslip preparations. Area under jaw: Small bacilli, with polar-staining and unstained middle piece like those described under coverslip preparations from (Edmundson) Animal No. 1—*B. bovisepticus.* Spleen: Same as

haemorrhagic area under jaw. Heart's blood: Same as haemorrhagic area under jaw.

Cultures. Anaerobic and aerobic cultures from all the sources noted under coverslip preparations were made in plain and dextrose broth and grown both at incubator and room temperatures. The cultures from all sources grown aerobically at incubator temperature gave most abundant growth of the organism, the same as those from similar cultures from Animals Nos. 1 to 4, inclusive—*B. bovisepticus*. Cultures grown anaerobically in the incubator were less abundant and consisted of the same organism. Cultures grown at room temperature gave only a very slight growth of the same organism.

Mr. Arth's herd consisted of 16 head of cattle. Six were attacked and died. No others showed any symptoms. The hygienic measures noted under Outbreak No. 1 were followed here also. In addition, 5 per cent carbolic acid and 1.1000 corrosive sublimate solutions were used freely about the barn and shed, where burning with straw, etc., was impracticable.

OUTBREAK NO. III.

The third outbreak began about September 20, on the farm of Mr. Joseph LaVoix, 1½ miles east of Clarissa, Minn., and 110 miles northwest of the location of Outbreak No. II. At this time rains were frequent, but a cooler temperature had given temporary relief from the flies and mosquitoes. The animals were in a wild pasture containing much heavy timber and underbrush. The ground was low and in places very wet. The soil was a heavy, black, sandy loam. The cattle, 25 in number, were of all ages, from sucking calves to 5-year-olds. On September 20, 12 head, including 4 sucking calves and 2 of their mothers, were found dead in the pasture. The remainder of the herd were changed to another pasture of similar character. On September 22, a 6-months' old heifer was noticed walking stiffly and refusing food and drink. The animal was placed in the barn. On September 23, the owner noticed a yearling steer walking stiffly and disinclined to eat or drink. Early in the morning of the 24th the animal passed faeces apparently normal in color and consistency, but streaked with bloody mucous. Shortly afterward he died.

On September 25, Dr. Brimhall visited the farm and made first an autopsy on the steer, which had been dead 26 hours.

Autopsy on (Lavoix) Animal, No. 6.

This animal had apparently died without a struggle. The abdomen was much distended with gas. In the subcutaneous connective tissue about the digits and scattered over other portions of the body, numerous small haemorrhagic areas were found. All the tissues about the throat were filled with a haemorrhagic exudate. The neighboring glands were haemorrhagic. The blood was somewhat darker than in the cases recently dead, but otherwise apparently normal. The pericardial sac contained a quantity of bloody serum. Haemorrhagic areas were scattered through the heart walls. Numerous haemorrhagic areas were present in the walls of the stomachs and bowels. The spleen was normal in size and contained a few haemorrhagic areas. The pulp was somewhat darker and softer than normal. The walls of the stomach and bowels showed numerous small and medium size areas of haemorrhage. The liver showed quite marked (post mortem?) changes. The kidney and bladder showed no marked change. The lungs showed hypostatic congestion.

The surface of the heart was cauterized, an incision made with a sterile knife, and sterile cotton swab immersed in the blood. The swab was then replaced in its tube and taken to the laboratory.

Bacteriological Examination of (Lavoix) Animal, No. 6.

From the swab, inoculated 16 hours previously with the heart's blood of (Lavoix) Animal No. 6, tubes of plain broth were inoculated and grown both at room and incubator temperature. In those grown at room temperature many large (putrefactive?) bacilli, B. coli communis and a few small, polar-staining bacilli developed. The incubated cultures yielded *B. coli communis* and many of the same small polar-staining diplo-bacilli seen in unincubated cultures. These, when grown in parallel cultures with morphologically similar bacilli from other sources, proved to be indistinguishable from those isolated from Animals Nos. 1 to 5, inclusive—*B. bovisepticus*.

On the morning of September 25, Mr. Lavoix noticed a yearling steer apparently sick. On Dr. Brimhall's arrival in the afternoon, a boy was sent to drive the animal from the pasture, but instead, found it dead. An autopsy was made at once.

Autopsy of (Lavoix) Animal, No. 7.

This animal, a yearling steer, had been dead about four hours. When he fell, one of his horns was driven into the ground. The earth where he fell was undisturbed, indicating that he died without a struggle. Faeces streaked with bloody mucus had passed the rectum just before death. In the subcutaneous tissue about the digits were a few small haemorrhagic areas. A few of these same areas were found under the superficial muscles and the shoulder. The tissues about the throat were congested and infiltrated with a bloody exudate. The cervical lymphatics were enlarged and haemorrhagic. The lungs showed no marked change. The blood was apparently normal. The pericardium showed no gross lesions. The heart

wall contained a very few small haemorrhagic areas. The spleen showed a few haemorrhagic areas on its surface, but was otherwise unchanged. The haemorrhagic lesions in the stomach walls were small in size and few in number. The abdominal cortex contained a large quantity of bloody serum. An intense general peritonitis obscured the small haemorrhagic lesions that were present in the intestines. The mucous membrane of the lungs was deeply congested. The mucous membrane of the intestines showed intense inflammation. The faeces were fluid and mixed with bloody mucus. The kidneys showed a few small points of haemorrhage in the cortex. The bladder walls were somewhat thickened and studded with small haemorrhages. Urine highly colored.

A portion of the spleen and a swab from the heart's blood were brought to the laboratory.

Bacteriological Examination of (Lavoix) Animal, No. 7.

Direct coverslip preparations from the spleen showed a few diplococcus-like bacilli.

Plain broth cultures were sown from the swab from the heart's blood and spleen and grown at room and incubator temperatures. In those sown from the swab, no growth occurred. Of those from the spleen, the tubes grown at room temperature showed a slight and the incubated ones a very abundant growth of the small polar-staining bacillus found in Animals Nos. 1 to 6, inclusive—*B. bovisepticus.*

In Mr. Lavoix's herd, a 6-months old calf had been sick about 3 days. When taken sick, this calf was in good flesh, but was now reduced to a mere skeleton. The conjunctival and other mucous membranes were colorless. Bloody serum was discharged from the bowels. There were no swellings about the throat or legs. The animal was bled and an autopsy held at once.

Autopsy on (Lavoix) Animal, No. 8.

The skin was removed from about the digits and a few small haemorrhagic areas were found. The tissues generally were very pale and but few areas of haemorrhage were found scattered in the superficial tissues of the body. The blood was very light colored. The pericardium was free from lesions. The heart wall showed numerous small haemorrhagic areas. The lungs showed no marked lesions. The spleen showed a number of small haemorrhagic areas, but was otherwise normal. The stomach walls showed very few small and superficial haemorrhages. The intestines were very pale and empty. The intestinal wall contained a number of small haemorrhagic areas. The kidneys were only slightly affected. The bladder was normal and contained apparently normal urine.

A portion of spleen and a swab from the heart's blood were brought to the laboratory.

Bacteriological Examination of (Lavoix) Animal, No. 8.

Direct coverslip preparations from the spleen showed a very few diplococcus-like bacilli.

Plain broth cultures were sown from the spleen and swab from heart's blood noted above and grown at room and incubator temperatures. But scant growth occurred in the unincubated cultures, while in the incubated ones an abundant growth developed. But one species of organism was present in all the cultures and that was the small diplococcus-like bacillus found in animals Nos. 1 to 7, inclusive—*B. bovisepticus.*

September 29, Mr. Lavoix lost another animal, and shortly afterward 2 more died. Thus, of a herd of 25 cattle, he lost 18. All that showed any evidence of the disease died. It may be noted that at the time of the first autopsy, the owner was instructed to take the hygienic precautions followed in the previous outbreaks. This, however, he failed to do.

OUTBREAK NO. IV.

The fourth outbreak began the last of October, 1900, on the farm of Mr. A. Claudius Johnson, of Kost, Minn., 16 miles northeast of the scene of the second outbreak.

The weather at this time was cold, though the ground was not frozen. Mosquitoes and flies had disappeared. The cattle were in a clean pasture consisting chiefly of clover. Their water supply was a small, rapidly flowing river. There were 13 animals in the herd. About October 20, 2 died, and October 30, 2 others became sick and died late in the evening. All had apparently the same disease. They refused food and water, walked stiffly and had a slightly bloody discharge from nostrils and rectum.

Dr. Brimhall, being at this time engaged on another investigation, Dr. M. H. Reynolds, Veterinarian to the State Agricultural Experiment Station and a member of the State Board of Health, having expressed a desire to see some cases of haemorrhagic septicaemia, was invited by Dr. Bracken, secretary and executive officer of the State Board of Health, to assist in the investigation of this, a probable outbreak. Accordingly he and Dr. Wilson visited Mr. Johnson's farm October 31, and made autopsies on the bodies of the 2 animals which had been dead about 16 hours.

Autopsy on (Johnson) Animal, No. 9.

No abrasions were noticed on the skin. On removing the skin, no haemorrhagic areas were found about the ankles, but many were present from a pin point in size to two or three inches in diameter, particularly about the shoulders and in the neck region. These haemorrhagic areas showed considerable oedema in some regions. The submaxillary glands were somewhat involved, as were all the structures in the region of the pharaynx. The pharynx and trachea were intensely congested. Internally, small haemorrhagic areas were present in the heart muscle, spleen, stomach and intestines. The kidneys appeared but slightly affected. The urine was not bloody. The dura surrounding the cervical portion of the spinal cord, and the synovial membrane of the thigh, knee and ankle joints all showed small haemorrhages. Considerable post mortem change had occurred in this animal and somewhat obscured the lesions caused by the disease.

Direct coverslip preparations, swab inoculations, uncontaminated pieces of tissue and tissue in fixatives were collected and brought to the laboratory for examination.

Bacteriological Examination of (Johnson) Animal, No. 9.

Direct coverslip preparations from a haemorrhagic area in subcutaneous connective tissue, a lymphatic gland, heart's blood and spleen all showed diplococcus-like bacilli, the same as those found in Animals Nos. 1 to 8, inclusive—*B. bovisepticus.* Many of the large putrefactive bacilli already described were also present.

Plain broth cultures were grown aerobically and glucose broth cultures anaerobically at both room and incubator temperatures. The large bacillus grew abundantly only in the tubes kept at room temperature. In the incubated tubes an abundant growth of the same bacillus as that found in Animals Nos. 1 to 8, inclusive, occurred—*B. bovisepticus.*

Autopsy on (Johnson) Animal, No. 10.

The lesions noted in this animal—except for the fact that decomposition was much less advanced—did not differ materially from those noted under Animal No. 9, and for the sake of brevity will not be redescribed.

Bacteriological Examination of (Johnson) Animal, No. 10.

Direct coverslip preparations from a haemorrhagic area over the flank, a cervical lymph gland, spleen and heart's blood, all showed a few of the diplococcus-like bacilli noted under Animals Nos. 1 to 10, inclusive—*B. bovisepticus.*

Plain broth cultures were grown aerobically and glucose broth cultures anaerobically at both room and incubator temperatures. Only the small diplococcoid bacillus—the same as that found in Animals Nos. 1 to 9, inclusive—*(B. bovisepticus)* developed.

Plain broth cultures were grown aerobically and glucose broth cultures anaerobically at both room and incubator temperatures. Only the small diplococcoid bacillus—the same as that found in animals Nos. 1 to 9, inclusive—*(B. bovisepticus)* developed.

November 12, Mr. Johnson reported that he had another animal sick. Drs. Reynolds and Wilson again visited his farm, but found the animal in question in apparently perfect health, it having been "stupid looking" only for a few hours. November 28, Mr. Johnson again reported an animal sick. It also made a rapid recovery. The probability of either of these animals having the disease from which their companions died may well be questioned, though within the bounds of possibility. Aside from these two, all the others (4) that showed any symptoms died. The same hygienic measures were followed here as in Outbreaks Nos. I. and II.

OUTBREAK NO. V.

The fifth outbreak began Nov. 18, 1900, on the farm of Mr. Thos. McNaughton, residing 7 miles southeast of Vesta, Minn., and 120 miles southwest of the scene of Outbreak No. I. The weather at this time was quite cold and dry, the ground being frozen and covered with snow. The farm is on a clear, rolling prairie and well drained. The cattle had been pastured on winter rye, but shortly before the outbreak had been permitted to run for a portion of each day in a field of standing corn stalks. There were 30 head of cattle in the herd.

November 18 Mr. McNaughton noticed three of hs cows ailing. The animals seemed to be in pain; very soon dropped to the ground, where they struggled for a short time and died in 6 hours after the symptoms were first noticed. There was considerable sweating along the neck, and all of them had some bloody discharge from the bowels. Spasms of the muscles of the shoulder and neck were noticed. When the animals were skinned shortly after death, some "bruised" places were noticed back of the shoulders and along the spine. One of the animals, after skinning, was opened by the owner. Nothing seemed to be wrong except some "bruised" patches on the heart and bowels. The animals were then covered deeply with straw to prevent freezing.

Autopsies were made by Drs. Brimhall and Wilson, on the two unopened animals in the morning of November 21. The external portions of the bodies were frozen, and but little evidence of decomposition was present anywhere within the animals. Long exposure to the atmosphere and covering with straw made it impossible to determine the nature of the superficial lesions.

Autopsy on (McNaughton) Animal, No. 11.

On removing the external layers of muscle and the foreleg, large and small haemorrhagic areas were found scattered through the muscles and fascia. The cervical glands were enlarged and haemorrhagic. Internally, the pericardial sac was filled with bloody serum. The heart muscle, portions of the lung, spleen, liver, stomach and intestines showed scattered haemorrhagic areas. The urine contained no blood.

Direct coverslip preparations, swab specimens, serum inoculations and portions of tissue were collected from a haemorrhagic area in muscle, heart's blood and spleen.

Bacteriological Examination on (McNaughton) Animal, No. 11.

Direct coverslip preparations from a haemorrhagic area in the muscle, heart's blood and spleen showed a very few diplococcus-like bacilli.

Plain broth and serum cultures were grown aerobically and glucose broth and glucose agar cultures anaerobically at both room and incubator temperatures. The incubated plain broth and other cultures—except the unincubated anaerobics—gave a slight growth of the small diplococcus-like bacillus found in Animals Nos. 1 to 10, inclusive—*B. bovisepticus.* The unincubated anaerobic sowings did not grow.

Autopsy on (McNaughton) Animal, No. 12.

The observers were so chilled by the intense cold—after having completed autopsy No. 11—that only a hasty examination of animal No. 12 was made.

The foreleg was removed, revealing numerous large and small haemorrhagic areas in the muscles and fascia. On opening the body, the lungs were found apparently normal. The pericardium, heart muscle, spleen, stomach and intestinal walls all showed numerous large and small haemorrhagic areas. No lesions were found in the hasty examination of the liver, kidneys and bladder.

A portion of the spleen and a bulb of heart's blood were taken to the laboratory.

Bacteriological Examination of (McNaughton) Animal, No. 12.

Direct coverslip preparations from the spleen and heart's blood showed a few diplococcoid bacilli and a few large (putrefactive) bacilli.

Plain broth and serum cultures were grown aerobically, and glucose broth and glucose agar cultures anaerobically at both room and incubator temperatures. The incubated plain broth cultures gave an abundant growth of the diplococcoid bacillus the same as that found in Animals Nos. 1 to 11, inclusive—*B. bovisepticus.* The incubated serum and anaerobic cultures gave a very faint growth of the same organism. The unincubated serum and anaerobic cultures gave a growth of the large putrefactive bacillus previously noted. The unincubated plain broth cultures gave a growth of both diplococcoid and large putrefactive bacilli.

Mr. McNaughton lost only the three cows (out of a herd of 30) noted above. No other cattle in the herd showed any symptoms. The same hygienic measures noted under outbreaks Nos. I. and II. were also followed here.

OUTBREAK NO. VI.

The sixth outbreak began Nov. 18, 1900, on the farm of Mr. Herman Klopke, who lived adjoining Mr. McNaughton (see Outbreak No. V.) This herd consisted of 11 head of cattle of various ages. These cattle had the liberty, during the day, of a field of corn stalks and were fed hay in the stable at night. There was no communication between the cattle on this farm and those on the farm where Outbreak No. V. occurred.

On Sunday, November 18, Mr. Klopke found one of his animals dead. Monday, another died; Tuesday, a third, and Wednesday, November 21, the fourth, a yearling heifer, died. The animals all began by drooping, getting very weak, dropping to the ground and dying without much struggling within 8 to 10 hours after first exhibiting symptoms. All had diarrhoea, and 3 of the 4 had some bloody discharge from the bowels. The last one to die was examined within 1 hour after death by Drs. Brimhall and Wilson.

Autopsy on (Klopke) Animal, No. 13.

No external lesions were noted. On removing the skin some small haemorrhagic areas, especially about the shoulders and digits were found in the subcutaneous tissue. The cervical and inguinal glands and udder also showed haemorrhage.

Internally, the pericardial sac contained bloody serum. The heart muscle, portion of lung, liver, spleen, stomach and intestines showed scattered haemorrhagic areas. The urine was not bloody. The kidneys showed no gross changes.

Direct coverslip preparations, swab specimens, serum cultures and portions of tissue were collected from a haemorrhagic area in muscle, heart's blood and spleen and taken to the laboratory.

Bacteriological Examination of (Klopke) Animal, No. 13.

Direct coverslip preparations from the heart's blood showed no bacteria. Those from the muscle and spleen showed a few diplococcus-like bacilli.

Plain broth and serum cultures were grown aérobically and glúcose broth and glucose agar cultures anaerobically at both room and incubator temperatures.

All the sowings except the unincubated anaerobes which did not grow, developed only the small diplococcus-like bacillus found in Animals Nos. 1 to 12, inclusive—*B. bovisepticus.*

Of the 11 head of cattle in his herd, Mr. Klopke lost only the four animals noted above. No others showed any symptoms. The same hygienic measures used in previous outbreaks were here taken.

OUTBREAK NO. VII.

This outbreak occurred on the farm of Mr. T. Caffrey, 2 miles north of Cokato, Minn., and 58 miles southeast of the scene of the second outbreak. The disease began with the last week in November, 1900. The weather at this time was cold and dry. Snow covered the ground. The cattle were allowed to run in a hilly woods pasture, clear of underbrush, and were fed in the barnyard on cornfodder from the shock. The 13 head of cattle of which the herd consisted were mostly cows and yearlings. In the week preceding November 29, six head died. The animals all exhibited the same symptoms. They refused food, stood "humped up," walked stiffly, passed black, tarry stools, in some cases streaked with blood, and died in from 6 to 15 hours after the onset of symptoms.

Dr. Hela, a local veterinarian, made autopsies on two of the animals and reported the cases to Dr. M. H. Reynolds, under the impression that he was veterinarian to the State Board of Health.

November 29, Dr. Reynolds and Dr. Wilson, in company with Dr. Hela, visited the farm and found another animal sick. An autopsy was made on the body of a cow dead on the previous day. Dr. Reynolds remained another day at the farm to make further observations and photographs, which he will probably publish later.

Autopsy on (Caffrey) Animal, No. 14.

The animal had been skinned and was slightly frozen externally, so that the subcutaneous lesions were obliterated. Some of the cervical glands were markedly enlarged and haemorrhagic. All of the internal organs showed haemorrhagic areas from pin point in size to three-fourths of an inch in diameter. These were most marked in the small intestine. A portion of the spinal cord and the joint surfaces of the limbs were laid bare, but no haemorrhagic areas were present.

Direct coverslip preparations, swabs and tissues from a cervical lymph gland, the spleen and heart's blood were collected and brought to the laboratory 16 hours later by Dr. Wilson.

Bacteriological Examination of (Caffrey) Animal, No. 14.

Direct coverslip preparations from a cervical lymph gland showed no bacteria. Those from the heart's blood and spleen contained a few diplococcoid bacilli.

Plain broth and agar cultures were grown aerobically and glucose broth and agar cultures anaerobically at both room and incubator temperatures

Only one species of bacteria developed—the small diplococcoid bacillus found in all the animals previously described—*B. bovisepticus.* The most abundant growth was in the broth cultures inoculated aerobically. The unincubated anaerobic sowings failed to grow.

The calf noted above as sick November 30, died early in the morning of December 1. On the same day a yearling (?) became ill and died (December 2?). Thus 8 out of a total of 13 cattle in the herd died. No others showed any symptoms. The hygienic measures previously noted were here also prescribed.

OUTBREAK NO. VIII.

The eighth outbreak began Dec. 11, 1900, on the farm of Mr. Henry Hager, situated 3 miles southeast of Kellogg, Minn., 65 miles southeast of the location of the first outbreak. The weather at this time was unusually warm for this season of year. For a number of days the ground thawed enough to make it quite muddy, but froze slightly each night. The cattle had been kept in a field of uncut but husked corn. The herd originally contained 26 head of cattle of various ages. On December 11, 2 cows were taken sick and died in about 8 hours. The owner thought the corn stalks were the cause of death and had the cattle removed from this field for a few days, but as no more were taken sick, they were again returned to the field. On the morning of December 14, when the owner went to the barn yard, he found 3 animals down and unable to get up. Another was standing up but was unable to move. He soon fell down and died in a few hours. The other three died in about 9 hours. The owner skinned the first 2 animals and noticed bloody spots along the back and inside of the legs. The owner thought they all bloated before death and showed twitching of the muscles of the neck and shoulders. Pain seemed intermittent as they lay quiet for a time, then the muscles twitched and trembled and the animals made a moaning noise. One animal passed blood-stained faeces.

On the morning of December 18 Dr. Brimhall visited the farm and made autopsies on the 4 cattle which had died about 16 hours previously.

Autopsy on (Hager) Animal, No. 15.

This animal was a six-year-old cow. When the skin was removed the superficial blood vessels about the posterior quarters were found markedly distended with dark blood. A large haemorrhagic area was present back

of the right shoulder. The udder was intensely congested and haemorrhagic. The blood was dark and clotted in the vessels, but became lighter colored when exposed to the air. The tissues about the throat showed no marked change. The inner thoracic walls were studded with small haemorrhagic areas. The lymphatics under the spinal column were enlarged and haemorrhagic. The pericardial sac showed these same areas in great abundance on the outer surface, and a few on the inner. Externally, the heart wall showed many haemorrhagic areas. The lungs were congested and a portion of the anterior lobes consolidated. The spleen contained numerous small haemorrhagic areas. The pulp was somewhat dark and softer than normal. The stomach and intestines contained a very few small haemorrhagic areas. The kidneys contained a few punctiform haemorrhagic areas in the cortex. The bladder was apparently normal and contained normal looking urine. The liver showed no gross lesions. The heart, spleen and udder were taken to the laboratory 24 hours after death.

Bacteriological Examination of (Hager) Animal, No. 15.

Direct coverslip preparations and serum, agar and plain broth cultures were made from the heart's blood, spleen and udder in the laboratory 24 hours after death of the animal. Direct coverslip preparations from the heart's blood and spleen showed no bacteria. Those from the udder showed a few diplococcoid bacilli.

The cultures noted above were grown aerobically only, at room and incubator temperatures. Those kept at room temperature showed no growth after 24 hours, but after two days a scant growth developed in the broth cultures. Those incubated gave an abundant growth from all three sources in broth. The incubated agar cultures from the heart's blood and udder gave a scant growth; those from the spleen, no growth. No growth occurred on any of the serum slopes. All the bacteria which developed were apparently of the same species—the small diplococcoid bacillus found in all the animals previously described—*B. bovisepticus.* The bacilli from this case showed quite long chains closely resembling streptococci in broth.

Pathogenesis.

December 19, rabbit No. 412, weight, 1,124 grams, was inoculated in the posterior left ear vein with 1 c. c. of a 24-hour incubated aerobic plain broth culture, orginal from udder of (Hager) Animal No. 15.

December 24, five days after inoculation, the animal was found sick at 9 a. m. and dead at 2 p. m. An autopsy was made at once. Considerable yellow sero-fibrinous exudate was found in the subcutaneous connective tissue of the ventral portions of the body. A few small haemorrhagic points were also present in the subcutaneous connective tissue. The mucous membrane of the trachea was congested. The lungs appeared normal. The right heart was distended with fluid blood apparently normal in color. A small amount of serous exudate, slightly reddened, was present in the abdominal cavity. The spleen was enlarged, soft and dark colored. A few small haemorrhagic points were present in the walls of the stomach and intestines. The intestines were filled with yellow mucus. The liver was congested. The kidneys and bladder showed no gross lesions.

Direct coverslip preparations from the (a) peritoneal fluid showed many; from the (b) spleen, a few; and from the (c) heart's blood, a very few small diplococcoid bacilli indistinguishable morphologically from those found in the tissues of the cow from which the cultures were originally obtained—*B. bovisepticus.*

Cultures on serum, agar and in broth developed only one species of bacterium, that the small diplococcus-like bacillus present in the original cultures—*B. bovisepticus.*

Autopsy on (Hager) Animal, No. 16.

This was a three-year-old steer. The abdomen was greatly distended with gas. The mucous membrane of the anus was intensely congested. Under the left shoulder was an extensive haemorrhagic area. The fluid of this area had infiltrated the surrounding tissues, some small areas of haemorrhage were scattered over other parts of the body. The tissues about the throat were slightly infiltrated. The mucous membrane of the trachea was deeply congested. The blood was dark and clotted in the vessels. The lungs were normal, aside from the accumulation of gas in the interspaces—probably post mortem. The pericardium contained only a few small haemorrhagic areas. The external surface of the heart muscle showed very slight change, but a marked haemorrhagic area was found in the muscle wall of the left ventricle. The diaphragm contained one large haemorrhagic area. the abdomen contained a large quantity of bloody serum. The spleen showed a few small areas of haemorrhage on its surface. The pulp was very dark and soft, due to post mortem changes. The stomach showed a few large haemorrhagic areas. The intestinal wall contained a few small areas of haemorrhage. The liver showed only post mortem change. The kidneys were markedly decomposed. The bladder showed no gross lesions and contained normal looking urine. The spleen was taken to the laboratory.

Bacteriological Examination of (Hager) Animal, No. 16.

Direct coverslip preparations and serum, agar and broth cultures were made from the spleen in the laboratory 24 hours after the death of the animal. Direct coverslip preparations showed a few small diplococcus-like bacilli, small, rather evenly-staining bacilli, and many large bacilli.

Cultures were grown only aerobically at room and incubator temperatures. All showed a heavy growth after 24 hours. The colonies on agar and serum proved to be mostly B. coli communis in the incubated tubes, and B. coli communis mixed with a large putrefactive bacillus in the unincubated tubes. The broth cultures gave mixtures of the same bacilli, and in addition, in the incubated broth cultures, many small diplococcoid bacilli, which, when isolated, proved to be the same as those found in all the previous animals—*B. bovisepticus.*

Autopsy on (Hager) Animal, No. 17.

This was a two-year-old heifer. When the skin was removed no haemorrhagic areas were found about the legs, but extensive haemorrhagic areas were found under the shoulders and superficial muscles. The tissue about the throat showed no marked change. The blood was slightly darker

than normal. The pericardium showed externally a number of small haemorrhagic areas. The external surface was normal. The heart was very slightly haemorrhagic and was filled with a dark clot. The thoracic walls were studded with small haemorrhagic areas. The lungs showed no gross lesions. One large area of haemorrhage was found on the third stomach (omasium). There were a few small areas on other portions of the stomach and in the walls of the intestines. The spleen pulp was silghtly darker in color and somewhat softer in consistency than normal. A few small haemorrhagic areas were found on the surface of the spleen. The liver showed no gross lesions. Externally the kidneys showed no gross lesions, but small haemorrhagic areas were found in the pelvis and ureters. The uterus contained a four-months-old foetus, and the placental membranes showed a few small haemorrhagic areas. The bladder was apparently normal. The spleen was taken to the laboratory.

Bacteriological Examination of (Hager) Animal, No. 17.

The spleen only was received in the laboratory, 24 hours after the death of the animal.

Direct coverslip preparations showed small diplococcus-like bacilli and large bacilli.

Serum, agar and broth cultures were grown aerobically at room and incubator temperatures. All room temperature cultures gave an abundant growth of the large bacilli. The incubated serum and agar gave a scant growth and the incubated broth culture an abundant growth of the small diplococcoid bacilli, the same as those found in all animals previously examined—*B. bovisepticus.* A few of the large bacilli were also found in the broth cultures, due either to the heavy original sowing or to the fact that the cultures stood sometime before they were put in the incubator.

Autopsy on (Hager) Animal, No. 18.

This was a steer one year old. No haemorrhagic lesions were noted about the digits. Extensive haemorrhagic lesions were found under the superficial muscles about the shoulders. The subcutaneous blood vessels of the hind quarters were markedly distended with dark blood. No marked lesions were found about the throat. The blood was dark and clotted. Externally the pericardial sac showed many small haemorrhagic areas, but none were found internally. The heart wall was extensively haemorrhagic. The thoracic walls were thickly studded with small haemorrhagic areas and the lymphatics of this region were enlarged and haemorrhagic, as were also the lymphatics extending the entire length of the spinal column. The stomach and intestines showed a few small haemorrhagic areas. The liver was apparently normal. The kidneys showed numerous punctiform haemorrhages. The bladder showed no gross lesions.

The spleen was taken to the laboratory.

Bacteriological Examination of (Hager) Animal, No. 18.

The spleen only was received in the laboratory, about 24 hours after the death of the animal. Direct coverslip preparations showed a very few diplococcoid bacilli and many large bacilli.

Serum, agar and broth cultures were grown aerobically at room and incubator temperatures. All those grown at room temperature developed an abundant growth of the large (putrefactive?) bacillus. The incubated agar and serum cultures gave a very scant growth, and the incubated broth cultures an abundant growth of the small diplococcoid bacillus found in all the animals previously examined—*B. bovisepticus.* A few of the large (putrefactive?) bacilli were also present in the incubated broth cultures. This may have been due to the very abundant original sowing or to the fact that the cultures stood sometime after sowing before being placed in the incubator.

Mr. Hager lost only the 6 animals noted above, out of his herd of 26.

The hygienic measures noted under previous outbreaks were here taken.

GENERAL DESCRIPTION OF HAEMORRHAGIC SEPTICAEMIA AS OBSERVED IN THE FOREGOING OUTBREAKS.

Local Conditions at the Beginning of the Outbreaks—No uniformity of local conditions prevailed. The weather at the beginning of Outbreaks Nos. I. and II. was hot and moist; during the time of Outbreak No. III., cool, and during Outbreaks Nos. V., VI. and VII., very cold and the ground frozen. Thus it would appear that in these outbreaks neither temperature nor moisture were essential predisposing factors, though the latter has been frequently noted as such in other countries. The number and voracity of mosquitoes and flies during the first three outbreaks suggested their possible agency in the conveyance of the disease. This, however, could not possibly have been the case during the last four outbreaks. Nothing constant concerning soil or drainage has been observed. There would appear to be a direct relationship between brushy pastures and marked lesions about the lower portions of the limbs, though it is improbable that the wounds caused by the brush should have been the avenues of infection.

Though the food or water or both may have been the vehicle for the ingestion of the bacteria causing the disease, the character of the food or water *per se* would appear to have no bearing on the infection. The wild nature of the pasture, part of it on low marshy ground in the first three outbreaks, might have led to the suspicion that the animals died from eating poisonous plants. In Outbreaks V., VI. and VIII., the fact that the animals were being fed on standing cornfodder, considered in connection with

the obscure symptoms, suddenness of death and the absence of marked external lesions had convinced the owners that their cattle died of "cornstalk disease." This opinion might have been shared by one unfamiliar with haemorrhagic septicaemia, who judged from the history alone.

Condition of Animals Prior to Infection—Age, sex and previous general good health were not determining factors in the infection, since animals of all ages, both sexes and in the best of health were attacked.

Onset and Course of Disease—The onset of the disease in every case has been sudden. In several of the outbreaks, the owner's first intimation of the disease was in finding several of his cattle dead in the pasture. The disease was rapidly fatal. In some of the cases, death occurred within 6 hours; in most of them within 24 hours, while a few lived 3 or 4 days.

Mortality—All the animals which showed any symptoms died,* a mortality of 100 per cent of affected animals. The number of animals originally present in each herd and the number which died is shown in the following table:

TABLE VII.

TABLE SHOWING NUMBER OF ANIMALS AND DEATHS IN AFFECTED HERDS.

	No. of animals originally in herd.	No. of animals which showed symptoms and died.
Outbreak No. I	26	15
Outbreak No. II	16	6
Outbreak No. III	25	18
Outbreak No. IV	13	4
Outbreak No. V	30	3
Outbreak No. VI	11	4
Outbreak No. VII	13	8
Outbreak No. VIII	26	6
Totals	160	64

Thus it will be seen that out of a total of 160 animals in the 8 herds affected, 64 or 40 per cent, showed symptoms and died.

Symptoms—The animals observed at the onset of symptoms appeared "dumpish" and "out-of-sorts." Sudden stopping of the

* The barely possible exception of the two animals noted in outbreak No. IV, should perhaps be mentioned in this connection.

milk secretion was present in milch cows. Most of them made no attempt to eat or drink. Of the few that did make the attempt, those with affected throats were unable to swallow except with great difficulty. These cases also breathed very heavily. The animals showed marked disinclination to move, and when incited to do so, exhibited stiffness, and in some instances, actual lameness. Some of the animals dropped to the ground and died in a short time, apparently without pain. Others were down when first observed to be sick and lived for several hours in great pain as indicated by groans, and spasms of the muscles. These attacks of pain were apparently intermittent. There was extremely rapid loss of flesh in the animals which were sick more than one day.

Opportunities for the accurate determination of temperature at the beginning of the disease were very few. It would appear that an initial rise—in one case to 105.6—was present, followed by a rapid decline. Painful, oedematous swellings about the legs, shoulders and under the throat were noted as early symptoms. The bowel discharges were often streaked with blood, while at other times a black, tarry or a bloody serous discharge was noticed. Bloody urine and a bloody serous discharge from the nose were present in some of the cases. The vaginal and rectal mucous membranes were intensely congested.

The marked swellings of the face, stomatitis, glossitis, convulsive movements of the jaws, etc., described by Friedberger and Fröhner[10] (quoted in part from Bollinger), under the exanthematous form of the disease were not observed in any of the recent cases. No instances of the pneumonic form of the disease as described by these authors were met with.

Morbid Anatomy—The characteristic lesions of the disease were areas of haemorrhage widely distributed, and varying in size from a pin point to several inches in diameter, and from light red to almost black in color. They were accompanied in most instances —though of less general distribution—with a sero-fibrinous exudate, usually yellow, but occasionally dark red in color. The haemorrhagic areas in the animals just dead were not so dark as those in animals dead some hours. The large areas—several inches in diameter—were apparently due, in some instances, to single haemorrhages infiltrating an extensive mass of tissue, and in others to a number of minute haemorrhages closely placed and partially coalescing. No gas was present in the subcutaneous connective tissue except in a few instances in which extensive

post mortem changes had occurred. The following is a more detailed description of the lesions:

External Appearance—(See description under symptoms, page 53.)

Subcutaneous Connective Tissue—An excessive fullness of the vessels of the subcutaneous connective tissue was present in some of the acute cases, especially in those animals which were not killed by bleeding. In the animals which lived until emaciation was marked, there was no engorgement of the vessels.

All the animals showed some haemorrhagic areas in the subcutaneous connective tissue, though the number and size of these varied greatly in the different cases. A few animals showed not over a dozen areas between an inch and an inch and a half in diameter, though many minute ones were present. In other animals, on removing the skin, the haemorrhagic areas were found in great numbers and so extensive that a large fraction—possibly one-eighth—of the body surface appeared to be involved. The largest haemorrhages in the subcutaneous connective tissue appeared to be of the composite type noted above.

The favorite location of the superficial lesions varied in the different animals. In most of them, the region about the shoulders was most affected; in some, the throat region, and in others, the digital region. In the gluteal and inguinal regions, a few showed marked lesions. When the skin had been removed some time before autopsy, the lesions in the subcutaneous tissue were much obscured.

Muscles—At first sight the muscle tissue in some cases appeared to be much involved. A closer examination, however, usually showed that while some the minute haemorrhages were in the muscle proper, the larger ones were in the intermuscular septa. Here also was frequently found a yellowish or blood stained serous exudate in considerable quantity. This connective tissue, where examined, appeared quite as much involved as the subcutaneous connective tissue, and where the lesions in the latter were obscured, as by long exposure of the skinned animal to the air, furnished a likely field for observation. Particularly was this true of the tissue under the shoulder.

Lymphatic Glands—These were frequently, though not uniformly nor constantly enlarged. Those which were enlarged were oedematous and often haemorrhagic. The most constantly and seriously affected were the cervical and pre-scapular.

Respiratory Organs—The nasal mucous membrane in some cases was congested, and a bloody serous discharge from the nostrils was present in a few instances. The tissues around the larynx were haemorrhagic and infiltrated with bloody serum. The mucous membrane of the larynx and trachea was more or less congested and covered with a frothy mucus, sometimes streaked with blood. In a few instances, no lesions were observed in the larynx or trachea. The lungs were in general almost free from evidence of disease. A few showed a small number of haemorrhagic areas, pyramidal in shape, with their bases on the pleura. One animal (No. 15) had consolidation of a portion of the anterior lobes of both lungs. In most cases, the parietal pleura was studded with small haemorrhages. The diaphragm sometimes contained very large haemorrhagic areas.

Circulatory Organs—The *pericardial sac* usually showed small —sometimes very numerous—haemorrhages in its walls, and in many instances contained bloody serum.

The *heart* walls, with but few exceptions, contained large and small haemorrhages. These sometimes extended deeply into the muscle. Similar areas of haemorrhage were also visible on the endocardium. The heart contained blood clots, *post mortem* in formation.

The *blood*, in the animals just dead, was somewhat lighter than normal in color. When *post mortem* changes had set in, the blood blood was darker in color, but reddened on exposure to air.

The *spleen* showed on its surface a few small haemorrhagic spots. It was usually normal in size, color and consistency, except where *post mortem* changes had taken place.

Digestive Organs—No stomatitis or glossitis was present. The pharynx was usually congested.

The *stomach* walls contained few or many haemorrhagic areas. These were sometimes extremely large, especially on the third stomach, of which, in one instance, the entire thickness of about half the wall, was involved. As a rule, the larger haemorrhages penetrated the entire thickness of the walls. The smaller ones were confined to the subserous or mucous coats. The stomach contents were apparently normal.

The *intestinal walls* were constantly affected. Haemorrhagic areas involving all the coats were frequently present. Smaller ones, visible only from the inner or outer aspects, were always present. General enteritis and peritonitis were present in one case. Localized enteritis was frequent.

The bowel contents were in some cases black and tarry; in others faeces apparently normal in color and consistency, but streaked with bloody mucus were present.

No gross lesions, excepting *post mortem* ones, were found in the *liver*.

Genito-Urinary Organs—The *kidneys* were usually but slightly affected. When lesions were present they were pin-point in size and mostly confined to the cortical substance, though a few were found in the walls of the pelvis and ureters.

The bladder wall in a few cases was oedematous and contained scattered haemorrhagic areas. A general cystitis was present in animal No. 5. The urine was bloody in a few instances.

The vaginal mucous membrane was congested in a number of cases. One animal, No. 17, which was four months pregnant, showed small areas of haemorrhage in the placental membranes.

The udder was congested and in some cases—e. g. No. 15—consisted of one mass of haemorrhage.

Central Nervous System—This was examined in but three cases, Nos. 9, 10 and 14. The first two showed haemorrhages of the dura. An examination of a small portion of the spinal cord (in No. 14) showed no lesions.

Synovial Membranes—The synovial membranes of the principal joints of the limbs were examined in animals Nos. 9, 10 and 14. No. 14 showed no lesions. Nos. 9 and 10 showed haemorrhages in all of the joint surfaces.

Morbid Histology—Portions of subcutaneous tissue, skeletal muscle, lymphatic glands, lung, heart wall, stomach wall and spleen, after fixation in 95 per cent alcohol and in 4 per cent formaldehyde solution, were stained by various methods and examined. In general, the lesions found were enormous extravasations of blood, some recent and some showing coagulation of fibrin. In the areas of less recent haemorrhage the surrounding tissues showed varying degrees of ordinary coagulation necrosis. This was particularly marked in affected muscles, lymph glands and portions of the lungs. In the borders of such necrosed areas, leucocytic infiltration was not infrequent. In the spleen, in which haemorrhagic areas were neither numerous nor large, there was, in some instances, an apparent destruction or shrinkage of the parenchyma.

Bacteriology—The bacillus found so uniformly present was recognized from the first as belonging to the haemorrhagic septicae-

mia* group of Hüppe[102] and best specifically designated as *bacillus bovisepticus* by Kruse.[20]

The organism is a bacillus, though from its tendency to show marked polar staining in tissues and to form chains of much shortened individuals in fluid media, it may be mistaken in examinations of a single specimen for a diplococcus or streptococcus. In the cultures from the recent outbreaks many of the long streptococcus forms as figured by Wertheim[303] were frequently met with. Sometimes in coverslip preparations from solid organs and very frequently in those from the body fluids and liquid cultures, the bacilli were found in chains of three to twelve individuals. In direct coverslip preparations the bacteria appear to be from 0.6 microns to 0.8 microns in transverse diameter, and from 1.0 to 1.5 microns in longitudinal diameter. In tissues which have been fixed in 96 per cent alcohol, the bacteria are somewhat less than the above dimensions, probably due to shrinkage by the fixation. In cultures, especially in fluid media, they are apt to be much less in size and closely approach diplococci in appearance. They are ovoidal in shape and the ends are always rounded.

In the specimens directly from the tissues, most of the bacilli have the ends intensely stained and the central portion but faintly so. In some chains in rapidly growing broth cultures this is not the case, but many of the individual bacilli are evenly stained throughout and may be somewhat pointed at the ends. Löffler's methylene blue brings out the polar stain to good advantage. The bacilli do not retain the stain by Gram's method. The organism is non-motile. It is aerobic, but prefers the depths rather than the surfaces of media. It will also give a faint growth anaerobically in glucose media even when the strictest precautions are used to exclude oxygen.* It grows best at incubator temperature and more slowly at room temperature. In plain and dextrose broth a heavy growth occurs in 24 hours. In Dunham's solution a small amount of indol is formed in 48 hours. Capaldi-

*The recent designation of this group of bacteria as "Pasteurella" by Trèvison and Lignieres, 24-82, is of somewhat doubtful propriety. Still more questionable is Lignieres designation of the diseases caused by the organisms as "Pasteurelloses." While there is certainly much need of a briefer and more accurate designation of the varieties of this group of bacteria and the lesions caused by them in different animal species, it would seem that our knowledge is at present not sufficiently definite to permit of dogmatic assertions as to the relations of the bacteria or their lesions, nor to warrant the adoption of a new nomenclature. For the present it would seem the wiser course to designate the diseases according to their lesions and as due to such and such bacteria. As for example, "Haemorrhagic septicaemia of cattle due to *bacillus bovisepticus*."

*The method of growing anaerobic cultures in this laboratory is a combination devised by Prof. F. F. Westbrock, director of the laboratory, and soon to be published.

Proskauer's No. 2 glucose medium is turned faintly acid after 24 to 36 hours, and partly decolorized at the bottom of the tube. Litmus milk becomes more acid and more decolorized up to 48 hours. No coagulation of the milk has appeared during 10 days' growth in the incubator. On Löffler's blood serum, cultures direct from the diseased tissues (16 animals tested) failed to grow well. Later cultures, after several generations in the incubator in broth, gave a fairly abundant growth on serum. The streaks have even edges slightly raised and are creamy white in color, not differing materially in tint from that of the opaque serum on which they are grown. On potato, no appreciable growth has been obtained with any of these strains. In gelatin plates, small, granular, white to slightly yellowish colonies appear after 48 hours. In gelatin stab cultures a light growth occurs on the surface, while along the needle track numerous colonies like those in the deep portions of plate cultures develop. On plain and glycerine agar slopes, a thin, narrow, granular, transparent growth occurs along the line of inoculation. The edges are slightly raised and uneven. On rabbits'-blood agar the growth is similar to that on plain agar, but much more abundant. In dextrose stab cultures, the growth occurs along the entire needle track and no gas is evolved. On agar plates colonies have much the appearance of those on gelatin, but develop more rapidly. Surface colonies are shiny, slightly translucent, whitish, circular discs with the edges regular and not elevated. The bacteria are destroyed in fluids at 58 degrees C. in 7 or 8 minutes, by 1 to 5,000 mercuric chloride in 1 minute, and by "a solution of lime water as weak as 0.04 per cent almost immediately." (Smith.[227])

The pathogenisis of the bacillus has been tested on pigeons, chickens, rabbits, guinea pigs and cattle.

Abstracts of the protocols of these animal experiments are herewith presented.

The protocols of the inoculation of Rabbits Nos. 379 and 381 are given on page 31; of Guinea Pig No. 397, on page 33; of Guinea Pig No. 396, on page 35; and of Guinea Pig No. 399, on page 37.

The following are additional ones:

Guinea Pig No. 398, weight, 630 grams, inoculated Aug. 31, 1900, subcutaneously in right groin with 1.5 c. c. of a 36-hour aerobic broth culture of *bacillus bovisepticus*, second culture from heart's blood of (Edmundson) Animal No. 3. Four days later animal was found dead in the morning. Autopsy revealed small haemorrhages throughout the organs. From the heart's blood and spleen pure cultures of the bacillus were obtained.

Guinea Pig No. 408, weight 162 grams, inoculated Dec. 18, 1900, intraperitoneally with 0.6 c. c. of original culture from heart's blood of (Hager)

Animal No. 16. Animal dead Dec. 22, 1900. Autopsy showed small haemorrhages in the lungs and spleen. Pure culture of *bacillus bovisepticus* isolated from the heart's blood.

Rabbit No. 409, weight, 1,110 grams, inoculated Dec. 19, 1900, in the left ear vein with 1 c. c. of a 24-hour broth culture of *bacillus bovisepticus* from (Hager) Animal No. 16. Dead Dec. 23, 1900, at 2 p m. Autopsy at once showed small and large haemorrhages scattered throughout the body. Pure cultures of the bacillus inoculated were isolated from the heart's blood.

Rabbit No. 410, weight, 1,055 grams, inoculated Dec. 19, 1900, in left ear vein with 1 c. c. of a 24-hour broth culture of *bacillus bovisepticus*, originally from (Edmundson) Animal No. 2 isolated Aug. 27, 1900. This animal showed no symptoms from the inoculation, the culture during the four months since its isolation having apparently lost its virulence.

Rabbit No. 412, weight, 1,124 grams, inoculated Dec. 19, 1900, in the left ear vein with 1 c. c. of a 24-hour broth culture of bacillus bovisepticus from (Hager) Animal No. 17. Animal died five days after inoculation. At autopsy considerable yellow serous oedema was found over the entire ventral portion of the body. Considerable serous effusion was present in the abdominal cavity. Small haemorrhagic points were found in the subcutaneous connective tissue, heart wall and spleen. *Bacillus bovisepticus* was obtained in pure culture from the peritoneal fluid, spleen and heart's blood.

Rabbit No. 413, weight 982 grams, inoculated Dec. 19, 1900, in left ear vein with 1 c. c. of a 24-hour broth culture of *bacillus bovisepticus* from (Arth) Animal No. 5. Culture had been in the laboratory since its isolation, Sept. 4, 1900, and produced no effect on the rabbit.

Pigeon No. 1, weight 435 grams, inoculated Dec. 28, 1900, in right breast muscle with 1 c. c. of a 24-hour broth culture of *bacillus bovisepticus* from (Edmundson) Animal No. 2. Pigeon found dead 9 a. m., Dec. 29. Autopsy showed haemorrhagic infiltration at the site of inoculation, and numerous small punctiform haemorrhages scattered throughout the internal organs. Pure cultures of the inoculated organism were obtained at the site of inoculation and from the heart's blood.

Pigeon No. 2, weight, 475 grams, inoculated Dec. 28, 1900, at 2 p. m., in the right breast muscle with 1 c. c. of a 24-hour broth culture of *bacillus bovisepticus*, isolated Oct. 11, 1900, from the inoculated calf, "Control D," see page 66. Pigeon found dead December 29, at 4 p. m. Autopsy showed haemorrhagic effusion at the site of inoculation and small haemorrhages in the heart muscle and intestinal wall. From the site of inoculation and from the heart's blood, the inoculated organism was recovered in pure culture.

Chicken No. 1, female, weight, 1,400 grams, inoculated Dec. 28, 1900, at 2 p. m. in the right breast muscle with 1 c. c. of a 24-hour broth culture of *bacillus bovisepticus*, isolated Oct. 11, 1900, from the inoculated calf "Control D," see page .... The chicken began drooping December 30, continued apparently sick until Jan. 5, 1901, after which time it apparently recovered. The bacillus had undoubtedly lost much of its virulence after its isolation.

Chicken No. 2, male, weight, 1,830 grams, inoculated Dec. 28, 1900, at 2 p. m., in the right breast muscle with 1 c. c. of a 24-hour broth culture of *bacillus bovisepticus* from (Hager) Animal No. 16. Bird quite sick December 29; remained ill until about Jan. 7, 1901, when it apparently recovered from the inoculation.

Calf No. 2, age 4 weeks, was inoculated Jan. 2, 1901, subcutaneously behind the left shoulder blade with 10 c. c. of an emulsion of five 24-hour serum slope cultures with a 48-hour plain broth culture of *bacillus bovisepticus* isolated 4 months previously from (Arth) Animal No. 4.

Calf No. 3, the same size and age as Calf No. 2, inoculated in the same manner with the same form of emulsion of *bacillus bovisepticus* isolated 3 weeks previously from (Hager) Animal No. 15.

Though the cultures used for these inoculations had probably become much attenuated since their isolation, yet both of the animals were apparently almost dead within 24 hours after their inoculation, but in a measure recovered. Six days later they were given twice the original dose, i. e. 20 c. c. of the same form of emulsion of the bacilli with which they had been originally inoculated. On the following day, January 9, when seriously ill, they were killed for purpose of autopsy before the Minnesota State Veterinary Medical Association. They both showed numerous small but typical lesions of the disease at the sites of inoculation, scattered throughout the subcutaneous connective tissue and in the internal organs. The inoculated bacilli were recovered in pure culture in both cases from affected cervical glands and heart's blood.

An examination of the foregoing protocols will show the following general facts:

Rabbits inoculated subcutaneously with small doses of pure cultures of the recently isolated organism died very soon. At autopsy the characteristic haemorrhagic lesions of the disease as observed in cattle were found distributed throughout the organs and the specific bacillus was recovered in pure culture from various diseased tissues and the heart's blood.

Guinea pigs inoculated in like manner with similar cultures in relatively larger doses, proved somewhat resistant to the disease, living sometimes as long as 6 days after the inoculation. *Post mortem* examinations showed haemorrhagic areas subcutaneously and in the internal organs. The specific bacilli were isolated in pure culture from the haemorrhagic areas, heart's blood, spleen, etc.

Only two *pigeons* were inoculated, and these with cultures which had been for some time in the laboratory. Both, however, promptly died, and at autopsy haemorrhagic lesions were found present throughout the body and the specific organisms were obtained in pure cultures from various sources.

Two *chickens* similarly inoculated with cultures which had been for some time in the laboratory, became sick within 24 hours, remained so for several days and then recovered. Though the experiments were too few to warrant drawing any very definite conclusions, it would appear that pigeons are highly susceptible to the inoculated organism, and chickens somewhat resistant.

Two sucking *calves*, and 1 6-months-old *heifer* ("Control D"), inoculated in each instance with bacteria which had been isolated for some time all developed typical symptoms and lesions of the disease. The specific bacilli were recovered in pure culture in all three cases from the heart's blood and various organs.

The experience in this laboratory thus coincides with that of other observers, that the bacillus is pathogenic for calves, rabbits, guinea pigs, chickens and pigeons, but that it is extremely difficult to maintain the virulence of the organism for any length of time after its isolation from naturally infected animals.

Diagnosis—The suddenness with which the animals die in many instances makes the diagnosis from symptoms alone extremely difficult or impossible.

Autopsies are demanded in every outbreak. Bacteriological examinations are equally necessary in the first outbreaks studied by a veterinarian, in a community, or when for any reason the lesions are obscured, as in the sub-acute form of the disease or from exposure of the skinned carcasses to the air. It may readily be confounded with anthrax, blackleg, "cornstalk disease" or poisoning. The occasional swelling of the neck, bloody discharges from the nose and rectum, bloody urine, and the sudden fatality makes many of the cases closely resemble anthrax. *Post mortem*, in animals recently dead, the light color and ready coagulability of the blood, the normal size, color and consistency of the spleen, and in any case, the absence of anthrax bacilli and the presence of *bacillus bovisepticus* should establish the diagnosis. Occasionally in young stock, the swelling, especially if not marked about the digits, the lameness and the rapid fatality may cause confusion with blackleg. The absence of crepitation due to gas in the swollen areas, and *post mortem*, the character and general distribution of the haemorrhagic areas, and the absence of the bacilli of symptomatic anthrax, in properly grown anaerobic cultures, with the presence of the *bacillus bovisepticus* will serve to accurately differentiate the two diseases.

In the fall and winter, when the cattle are running in standing cornfodder, as in Outbreaks V., VI., VIII., a sudden outbreak of the disease with rapid fatality, and, *post mortem*, the occasional finding of only small, though widely distributed haemorrhagic areas, may lead to a diagnosis of "cornstalk disease." Indeed, it is quite conceivable that some of the many so-called cases of this latter malady, which have occurred in the northwest this and previous years, may have been due to the *bacillus bovisepticus*.

Where the conditions are as above, the finding of the more marked *post mortem* lesions in other cases or the isolation of the specific bacilli alone from the organs, should determine positively the diagnosis of haemorrhagic septicaemia.

When cattle are in weedy pastures, the sudden onset, occasionally with absence of external lesions, and the rapid fatality may lead to strong suspicion of poisoning from plants. The presence, *post mortem*, of the characteristic lesions, or the isolation of the causative bacteria, will fix the diagnosis.

Treatment—The sudden fatality of this disease gives little or no opportunity for medical treatment.

Prophylaxis—The healthy cattle should be removed from the infected pastures at once. Division of the herd into small groups or individuals, with isolation of each, would be very desirable, and, where possible, should be done. Carcasses should be promptly burned or deeply buried, and the ground where they lay should be covered with straw or hay which should be burned until the ground is thoroughly heated. When cattle die in the stable all contaminated litter should be burned. The stable floor should be thoroughly saturated with a 5 per cent solution of carbolic acid. The walls and all woodwork should be thoroughly whitewashed with freshly slacked lime. Corrosive sublimate 1 to 1000 may be substituted for the carbolic acid.

Experimental Protective Inoculations—The inoculation of the well animals of an affected herd with filtered, killed or attenuated cultures of the specific organism promises to be of value as a protective measure. Much experimental work, however, yet remains to be done before this procedure will be warranted as a routine measure.

Early in the investigations of the recent outbreaks it seemed desirable to attempt protective inoculations of exposed animals along the line of the protective inoculations against chicken cholera already perfected by Pasteur and others. That such inoculations might be of possible good in the current outbreaks, it was decided to inoculate cattle direct, without waiting to determine accurate dosage, etc., through a necessarily long series of experiments on laboratory animals. The board was able to undertake these experiments immediately through the intelligent and unselfish coöperation of Mr. Joseph Arth, on whose farm one of the outbreaks occurred. Four animals were selected for the experiments and were designated "Vac. A," "Vac. B," "Vac. C" and "Control D," respectively.

"Vac. A" was a yearling steer weighing about 400 pounds. "Vac. B" was a yearling heifer weighing about 450 pounds. "Vac. C" was a yearling heifer weighing about 550 pounds. "Control D" was a 6-months-old heifer weighing about 300 pounds. The daily normal temperatures of these animals ranged from 101 to 102 degrees.

Sept. 12, 1900, a mixture of 24, 48 and 96-hour broth cultures recently isolated from cattle dead of the disease on the Arth farm were filtered through porcelain and the filtrate used for inoculation subcutaneously of the first three animals. "Vac. A" was given 1.5 c. c., "Vac. B," 1.0 c. c., and "Vac. C," 0.75 c. c. The temperatures of all rose slightly within the next 24 hours, that of "Vac. A" rising 1.5 degrees. "Vac. A" also showed a slight swelling and soreness at the site of inoculation.

The animals remained in good health for the next 8 days.

September 20 a mixture of equal parts of a 24 and a 48-hour broth culture of the bacillus recently isolated from another animal dead on the Arth farm was shaken up with an excess of chloroform and allowed to stand for 3 hours in a tightly stoppered flask. The stopper was then removed, the flask plugged loosely with sterile cotton and heated for one hour to 60 C. The supernatant fluid was then decanted from the sediment and used for subcutaneous inoculation of the first three animals of the series. Each animal was given 5 c. c. The temperature of all was but slightly elevated at the end of the next 24 hours. "Vac. A" was then given 10 c. c. more of the heated culture noted above (which in the meantime had stood for 24 hours in a warmly heated room, giving opportunity for the multiplication of any bacteria not killed by the previous treatment.) Within 12 hours the animal's temperature had risen 3 degrees F. It was apparently quite sick from this on, though no swelling occurred except at the site of inoculation, and no bloody discharges were present. The animal died 37 hours after the last inoculation.

Post mortem examination showed a very large haemorrhagic area at the site of the last inoculation. None were present at the sites of the first and second inoculations. Small haemorrhages were also present elsewhere in the subcutaneous tissues and internal organs, though not so abundant nor so large as those seen in the majority of the animals dead of the disease through natural infection. The legs were affected as in the other animals.

Direct coverslip preparations and cultures from the site of inoculation, spleen and heart's blood gave *bacillus bovisepticus* in pure culture.

The question might fairly be raised whether the animal was killed by a natural infection, by too large a dose in the experimental inoculation, or by a combination of the two. Unfortunately, there is no way of determining the matter absolutely, since the opportunity of studying the exact content of the material used for the third inoculation was lost at the time.

October 2 a mixture of a 24-hour, 48-hour and a 12-day culture from an animal dead of the disease on the Arth farm was used for inoculating subcutaneously animals "Vac. B" and "Control D." "Vac. B" was given subcutaneously 25.0 c. c. of the mixture, and "Control D," 10 c. c. of the mixture.

The heifer, "Vac. C," was also placed under the same surroundings as to food, housing, etc., and her temperature taken as control for the two inoculated animals. The temperatures for the next 60 hours were as follows:

	Vac. B.	Control D.	Vac. C.
Animals just driven in from pasture—			
October 2, 5 p. m................	103.3	103.6	103.4
Animals inoculated as noted above—			
October 2, 9 p. m................	102.9	105.3	102.4
October 3, 6 a. m................	102	103.8	101
October 3, 12 m..................	102	103.9	102
October 3, 6 p. m................	102.4	104.2	102
October 4, 6 a. m................	101.2	104.4	101.2
October 4, 12 m..................	102	104.3	102.1
October 4, 6 p. m................	102.6	104.8	102.4
October 5, 4 a. m................	102	105.4	101.3

The calves were all driven in from the pasture at the same time and placed in stanchions in a dry barn. They were fed only hay during the observations. The weather was very warm and moist for the season of the year. The animal previously inoculated, designated "Vac. B," showed absolutely no symptoms from the inoculation of the living culture, except a slight swelling and tenderness at site of inoculation for the first 36 hours. The animal previously uninoculated, designated "Control D," showed a marked rise of temperature (see table), which remained permanently elevated. The animal had a marked swelling and tenderness at site of inoculation which extended to the adjacent regions. Lameness was present after the first 12 hours. The animal remained lying on its side with its forelegs drawn up in a constrained position. At the end of the first 24 hours, all the observers were positive the calf would be dead before morning, but

while still very sick the next morning, after 36 hours, the calf was not dead, and by 8 a. m., 38 hours after inoculation, was apparently feeling somewhat better. At this time, in order, if possible, to hurry up the experiment and kill the animal more quickly, it was given subcutaneously on the left side of abdomen 15 c. c. more of the mixture used for the original inoculations. The symptoms were intensified from this on.

Oct. 11, 1900, "Control D," which, since its last inoculation, October 5, had appeared to be sick, though able to eat and move about fairly well, was killed and an autopsy made at once. No evidence of affection of subcutaneous tissue about the ankles was visible. On removing the skin at the sites of inoculations, there was found a small cavity (several inches in diameter) surrounded by a large area very oedematous and showing old and more recent haemorrhages. At one site of inoculation were two separate cavities, one very markedly walled off and filled with a clear fluid resembling serum more than pus. The other corresponding to this was not well walled off, but seemed to be composed of pockets lying in the interstices of the tissue. At some distance from one oedematous area, there were found a very few small haemorrhagic areas exactly resembling those seen in the clinical cases.

The lymph glands in front of the shoulder and along the neck generally, i. e., those draining the area directly affected by the inoculation, were all enlarged. The smaller ones were black and haemorrhagic throughout, and the larger ones were much darker than normal, apparently in a state of partial recovery from previous general haemorrhagic infiltration and contained here and there a few recent haemorrhagic areas.

The inguinal glands were similarly affected. No pathological lesions were found in any of the internal organs except the kidneys, which were much swollen with old and recent haemorrhages between the capsule, in the pelvis and between the lobules.

Direct coverslip preparations, cultures and tissues from (A) pus-cavity at site of inoculation; (B) oedematous area surrounding site of inoculation; (C) involved glands; (D) spleen; (E) kidney, were collected. The kidneys were preserved in Kaiserling's fluid.

After 96 hours in the incubator, all cultures, except those from pus at site of inoculation, remained sterile. Cultures from pus at site of inoculation gave pure growths of the inoculated organism—*B. bovisepticus.*

SUMMARY.

1. Eight outbreaks of haemorrhagic septicaemia in cattle, due to *bacillus bovisepticus*, occurred in Minnesota from August to December, 1900.

2. So far as can be determined, the only other outbreak of this disease hitherto published as occurring in America, was one near Knoxville, Tenn., in 1898. The foci of the disease have also apparently been present in Texas and the District of Columbia. (See page ... of this report.) No relation can be traced between the disease elsewhere and the present outbreaks, nor between any two of the present ones.

3. Of 160 animals in the 8 herds, 64 showed symptoms of the disease and all such died—a mortality of 40 per cent of all the animals in the herds, and of 100 per cent of those showing symptoms.

4. The chief symptoms were loss of appetite, fever, stiffness, swelling of the legs and throat and a black, tarry or bloody discharge from the bowels. Bloody urine and bloody nasal discharge were present in some cases. Death occurred usually in from 6 to 24 hours after the first appearance of symptoms.

5. The chief lesions discovered at autopsy were ecchymoses, and small and large haemorrhagic areas in the subcutaneous connective tissues, muscles, lymph glands and throughout the internal organs. The cervical lymph glands, heart muscle and alimentary canal were most affected. The spleen was not enlarged nor darkened (except after onset of decomposition.)

6. From the 22 animals on which autopsies were made, the same bacillus was obtained from all the tissues examined. Where the examination was made immediately after death—9 cases—it was unmixed with any other organism.

7. The bacillus was identified as belonging to the haemorrhagic septicaemia group of Hüppe, best specifically designated as *bacillus bovisepticus;* and besides causing haemorrhagic septicaemia in cattle (synonyms-rinderseuche, buffleseuche, barbone, khounnaq, charbon blanc, ghotwa, pasteurellosis bovina, etc.), closely resembles, if indeed, it is not identical with, the bacilli causing wildseuche, swine plague, schweineseuche, rabbit septicaemia, chicken cholera, grouse disease, duck cholera, etc. The organism was studied in direct coverslip preparations, parallel cultures in and on various media, and by inoculation of animals in which the

characteristic lesions were reproduced and from the tissues of which the inoculated bacilli were recovered in pure culture.

8. An attempt was made to immunize cattle by the injection of filtered and later of the killed cultures of the bacillus. The chief difficulties met with were in maintaining the virulence of the bacillus on artificial media and in determining the proper dosage. The experiments were too few and the results not sufficiently tested to warrant conclusive statements as to the protective value of the inoculations, but it would appear that a fairly high degree of immunity was produced.

9. The prompt removal of the dead animals and isolation of sick ones, accompanied by thorough disinfection by fire, carbolic acid, corrosive sublimate and freshly slacked lime apparently served to check each outbreak within a short time after the measures were instituted.

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REPORT

OF THE

BACTERIOLOGICAL LABORATORY.

1899-1900.

BY

F. F. WESBROOK, DIRECTOR.

INTRODUCTION.

The work of the laboratory for the years 1899-1900 has been more satisfactory than at any time since it was begun in 1896.

Greater systematization in method of examination and reporting has facilitated the work which has now come to be looked upon as routine.

During the two years relatively more time has been spent in investigation and special than in routine work, and whilst not all that had been planned has been accomplished an amount of success has attended the efforts made, which is both gratifying and is an earnest for the future. Much that was begun has been forced aside after it had been brought to the point where a preliminary report was possible, and before it could be carried to a satisfactory and scientific completion. New and pressing work has been the cause of this.

At this time no attempt can be made to fully analyze and present in complete form the work upon the serum diagnosis of typhoid fever, of which there are on record over 3,000 examinations, made by the laboratory since the last complete report. Much work has been and is being done upon those bacilli which are closely related to *bacillus typhosus* and *bacillus coli communis*, but a full report of the work must be deferred at present.

Rabies, a disease very prevalent in this state, and the study of which has been forced upon the notice of the laboratory, can only be here partially reported.

For the past two years the study of diseases of animals has received much attention, and has interfered markedly with the work which had been planned in human disease. However, the time spent in such study has certainly proved profitable, and no regret need be felt.

In this report it seemed best to make special features of the work in hæmorrhagic septicæmia amongst animal diseases and in diphtheria as representing human diseases, and they are therefore given somewhat in detail. Other investigations, for the most part, have been but briefly reported.

In all investigations where such has been possible, it has become more and more the policy of the laboratory to send out some

member of the staff to investigate conditions and collect specimens and data. This has been found to be by far the most satisfactory plan, and in the end is also less expensive, if the time and materials used in the investigation be reckoned.

It has been found that to depend upon physicians, veterinarians or health officers for the proper selection, collection and transmission of specimens and the furnishing of vital data, even when careful directions have been supplied, is ill advised. As an illustration of this, nothing could be more convincing than a comparison of the reports on sundry investigations of specimens of meat, fæcal material, pus, animal tissues, etc., which have been forwarded to the laboratory, usually in the most haphazard way, with those of the special investigations of animal diseases, such as hæmorrhagic septicæmia in cattle or cerebro spinal meningitis or the special investigations of diphtheria or other human diseases where a member of the laboratory staff has been able to make a personal visit at the proper time.

Many matters investigated are here reported which are of little value, except as they afford object lessons of "what not to do" and of how little can be learned unless the proper steps be taken from the very beginning. Perhaps one-quarter of the time of the staff has been employed during the last two years in painstaking work on materials, which through lack of proper attention and care in forwarding and incompleteness or total absence of data ultimately afforded nothing of any value either to the sender or to the laboratory.

In the study of animal diseases it seems absolutely necessary to send a trained bacteriologist with a careful and experienced veterinarian to study obscure diseases. In diseases of man it is hoped that the finances of the board will permit of the carrying out of the same policy to even a greater degree. In the investigation of water supplies this is absolutely necessary, and even the establishment of temporary branch laboratories for constant supervision and daily examination must be contemplated and provision made for it as quickly as possible.

The work in animal diseases, whilst gratifying, has been very seriously handicapped by lack of facilities for keeping infected domestic animals under observation. These must be had in abundance and provision made for their care and supervision by the laboratory, if much progress is to be made in the study of the obscure animal diseases, which seem so widely distributed in this portion of the country. It is hoped that ere long such a provision may be made and the laboratory staff increased so that the occa-

sional or continued absence in the field of one of its members may not interfere with regular routine and research work to such a degree as it has done during the past two years. The varied character of the work and the occurrence of emergency cases demands an increase in the staff, if the studies at present under way are to be completed without neglecting routine work, and if other problems, of which there are many awaiting solution, are to be attacked in such a way as to prove of the greatest benefit to the public health and commercial interests of the state.

DISINFECTION EXPERIMENTS.

The work undertaken during the years 1899-1900 has been of three kinds.

A. THE TESTING OF THE EFFICIENCY OF FORMALDEHYDE DISINFECTION AS CARRIED OUT BY PHYSICIANS AND OTHERS IN HOUSES OR STABLES AFTER THE OCCURRENCE OF INFECTIOUS DISEASE.

Test objects supplied by the laboratory were placed in various positions in the rooms where disinfection -was -attempted, and upon return to the laboratory culture media were inoculated. The tests applied were as follows:

1. Short lengths of silk, wool or cotton threads previously sterilized by dry heat were dipped into an emulsion of an old agar surface culture of bacillus subtilis containing spores or into a culture of bacillus prodigiosus. Whilst still moist, a subtilis thread was placed on one side and a prodigiosus thread on the other side of a glass tube* three to four inches long and one-half to three-quarters of an inch in diameter. The tube was open at both ends, and had been previously plugged with cotton at each end and sterilized by dry heat. As drying took place, the threads adhered firmly to the sides of the tube.

These tubes, then containing threads infected with both a spore-bearing and a non-sporulating bacillus, were easily forwarded by express without danger of contamination. When placed in various parts of the room the efficacy of the germicide used was easily tested both upon spores and bacteria. Penetration of the disinfectant could be gauged to some extent by not withdrawing the plugs in the tubes during disinfection. All data as to situation in room, technique used, etc., was noted. Upon return to the laboratory usually the threads infected with bacillus subtilis were planted in agar (usually pressed into the surface of a plate) and the prodigiosus threads sown upon potato. The growth of each being so characteristic, the use of the microscope was seldom or never necessary.

2. On several occasions ordinary cotton swabs, such as are used for taking throat cultures in diphtheria were employed. After they had been sterilized in a test tube plugged with ab-

*This method is described in the last biennial Report of the Minn. State Board of Health, p. 451.

sorbent cotton, they were withdrawn and dipped into an emulsion of a culture of either bacillus subtilis or bacillus prodigiosus, returned to the sterile tube and allowed to dry. For use they were withdrawn from the test tube and the free end of the wire thrust into cracks or some other suitable place in the room about to be disinfected. After the operation they were placed in sterile test tubes (not those from which they were withdrawn and whose walls had been presumably infected from the swabs when first introduced), plugged and returned to the laboratory where sowings were made.

3. A third method sometimes employed has been to supply the ordinary sterile diphtheria swab in a sterile test tube. After disinfection of the room and immediately upon opening it, the operator was instructed to enter and rub one of the swabs into dust in the cracks in floor, walls, ceilings or elsewhere, using one swab for each place. The swabs were returned immediately each to its own tube, labelled accurately as to what had been done and forwarded to the laboratory, where sowings were at once made.

B. ACCURATE TESTS OF GASEOUS DISINFECTANTS IN SPECIALLY SELECTED ROOMS IN THE LABORATORY OR UNDER THE DIRECTION OF A MEMBER OF THE LABORATORY STAFF.

During the latter portion of the investigation at the State Public School for Dependent and Neglected Children (January, 1899,) Dr. McDaniel made many accurate tests of sulphur and formaldehyde disinfection as applied to the rooms, furnishings, books, toys, clothes, etc., during the preparation of specially sterilized rooms for housing the children who had been found to be free of diphtheria and diphtheria like bacilli.

Dr. McDaniel's summary of results obtained may be given here.

I. AT STATE PUBLIC SCHOOL, OWATONNA, MINN., BY DR. O. McDANIEL.

"During this quarter, cottages III, IV and V, the two hospital buildings and the rooms in the main building frequented by children were disinfected.

All rooms in which formaldehyde was used had painted walls and ceilings with few cracks, which were sealed. All of the rooms in which sulphur was used, except in cottage IV, had hard finished plaster walls and ceilings.

The following table gives some idea of the effectiveness of the methods used."

TABLE NO. 1.

1. EXPERIMENTS IN SULPHUR DISINFECTION WITH THOROUGH SATURATION OF ATMOSPHERE WITH STEAM.

	Cubic feet.	Amount of Sulphur.	Tests.	Time of Exposure.	No. Showing Growth.
1. Cottage IV.	31,990	1 lb. to 212 cu. ft.	10 cotton swabs infected with a mixed throat culture on serum incubated 24 hours.	24 hours.	5
2. Cottage III basement.	11,543	1 lb. to 108 cu. ft.	5 cotton swabs, 5 tooth picks infected with a 24 hour mixed throat culture.	26 hours.	0
3. *Cottage V third floor.	......	1 lb. to 216 cu. ft.	12 swabs infected with 24 hour culture B. diphtheriæ.	39 hours.	0
4. Cottage V basement.	......	1 lb. to 108 cu. ft.	9 swabs infected with 48 hour culture B. diphtheriæ.	36 hours.	0

*In No. 3 the steam saturation was more complete than in others.

It will be seen that with a large amount of sulphur and thorough steaming the disinfection is complete, but it should be noted that considerable damage was done to light fixtures and water faucets, although they were closely covered with cloth. Also all cotton or woolen material exposed was destroyed. Painted surfaces were ruined.

TABLE NO. 2.

2. EXPERIMENTS IN FORMALDEHYDE DISINFECTION WITH TRILLAT AUTOCLAVE.

	Cubic feet.	‡Amount of formo-chloral Used.	Tests.	Time of Exposure.	No. Showing Growth.
1. Cottage IV first time.	27,796	1 lb. to 3,970 cu. ft.	14 swabs 24 hour mixed throat culture.	12 hours	12
2. Cottage IV second time.	27,796	1 lb. to 2,396 cu. ft.	10 swabs 24 hour mixed throat culture.	14 hours	6
3. Main Building employes' dining room.	11,184	1 lb. to 3,728 cu. ft.	8 freshly inoculated serum cultures from throats.	7 hours	8
4. Main Building children's dining room	30,342	1 lb. to 2,528 cu. ft.	9 swabs infected with 24 hour mixed throat culture.	18 hours	4
5. School Bldg. south room first floor.	8,581	1 lb. to 2,451 cu. ft.	7 swabs infected with 24 hour mixed throat culture.	21 hours	4
6. School Bldg. north room first floor.	6,948	1 lb. to 2,481 cu. ft.	5 swabs 24 hour mixed throat culture.	15 hours	5
7. School Bldg. north room second floor.	6,226	1 lb. to 2,510 cu. ft.	5 swabs 24 hour mixed throat culture.	13 hours	5
8. Cottage III west room first floor.	4,830	1 lb. to 1,933 cu. ft.	3 swabs, 3 toothpicks infected with 24 hour culture B. diphteriæ.	20 hours	1 swab
9. Cottage III north room first floor.	2,960	1 lb. to 1,973 cu. ft.	2 swabs 24 hour culture B. diphtheriæ.	17 hours	2 swabs
10. Cottage III east room first floor.	3,920	1 lb. to 1,960 cu. ft.	2 swabs, 3 toothpicks 24 hour culture B. diphtheriæ.	12 hours	2 swabs
11. Cottage III east dormitory second floor.	4,960	1 lb. to 1,550 cu. ft.	4 swabs, 4 toothpicks 24 hour culture B. diphtheriæ.	21 hours	0
12. Cottage III west dormitory second floor.	4,060	1 lb. to 1,504 cu. ft.	3 swabs, 3 toothpicks 24 hour culture B. diphtheriæ.	17 hours	0
13. Cottage III north room second floor	2,960	1 lb. to 1,973 cu. ft.	3 swabs, 3 toothpicks 24 hour culture B. diphtheriæ.	16 hours	1 swab
14. Cottage III halls.	3,920	1 lb. to 1,005 cu. ft.	4 swabs, 4 toothpicks 24 hour culture B. diphtheriæ.	18 hours	1 swab
15. †Store room containing school books, materials, etc.	750	1 lb. to 300 cu. ft.	*11 mixed throat cultures.	19 hours	4
16. †Store room containing same materials as in above.	750	1 lb. to 150 cu. ft.	*21 infected with pure B. diphtheriæ.	24 hours	3—one showed B. subtilis alone
17. †Store room containing library books, clothing, etc.	750	1 lb. to 143 cu. ft.	*17 infected with pure B. diphtheriæ.	17 hours	3—one showed B. subtilis alone

*Divers articles included toothpicks, cardboard, swabs, kindergarten sticks, books, etc. These were infected with cultures.

†In experiment 15 the walls and ceiling were of hard finished plaster. In experiments 16 and 17 the walls and ceiling had been painted.

‡It has since been found that the formo-chloral was not full strength.

TABLE NO. 3.

3. EXPERIMENTS IN FORMALDEHYDE DISINFECTION WITH THE LENTZ APPARATUS.

	Cubic feet.	Amount of Reagent Used.	Tests.	Time of Exposure.	No. Showing Growth.
Quarantine Hospital—					
1. S. E. room....	2,313	1 oz. to 50 cu. ft. 10% glycerine in 40% formaldehyde	6 swabs, 24 hour culture B. diphtheriæ.	22 hrs.	0
2. S. W. room...	2,281	"	8 swabs, 24 hour culture B. diphtheriæ.	20 hrs.	1
3. Back hall and medicine chest	978	"	8 swabs, 24 hour culture B. diphtheriæ.	18 hrs.	5—3 show'd B. subtilis alone.
4. East(play)r'm.	1,872	"	4 swabs, 24 hour mixed throat cultures.	24 hrs.	0
5. N. E. room...	1,872	"	4 swabs, 24 hour mixed throat cultures.	20 hrs.	0
6. N. W. room..	1,745	"	4 swabs, 24 hour mixed throat cultures.	20 hrs.	0
7. Front hall, clothes and bath.	2,451	"	7 swabs, 24 hour mixed throat cultures.	17 hrs.	1
General Hospital—					
8. Private rooms (suite) 1st floor.	2,452	"	8 swabs, 24 hour culture B. diphtheriæ.	5 hrs.	4
9. N.E. room, 1st floor.	3,506	"	8 swabs, 24 hour culture B. diphtheriæ.	16 hrs.	1
10. Private rooms 1st floor, 2nd time.	2,452	1 oz. to 50 cu. ft. 40% formaldehyde with borax.	4 swabs, 24 hour culture B. diphtheriæ.	24 hrs.	0
11. S.E. room, 1st floor.	3,082	"	7 swabs, 24 hour culture B. diphtheriæ.	20 hrs.	0
12. S. W. room, 2nd floor.	3,443	"	4 swabs, 24 hour culture B. diphtheriæ.	36 hrs.	0
13. N. W. room, 2nd floor.	2,719	"	3 swabs, 24 hour culture B. diphtheriæ.	20½ hrs.	0
14. N.E. room, 2nd floor.	3,357	"	5 swabs, 24 hour culture B. diphtheriæ.	40½ hrs.	0
15. S. (large) r'm, 2nd floor.	......	1 oz. to 50 cu. ft. 40% formaldehyde.	7 swabs, 24 hour culture B. diphtheriæ.	18 hrs.	0
16. Cottage II—(suite), private rooms.	3,430	"	4 swabs, 24 hour culture B. diphtheriæ.	4 hrs.	0

(a) After finishing experiments 1, 2 and 3, 27 oz. dark, thick liquid having a fairly strong odor of formaldehyde was left in retort.

(b) In experiment 8, at the end of 24 hours, 16 oz. of stronger ammonia was vaporized by means of the Lentz apparatus, the rooms opened 12 hours later and the disagreeable odor was scarcely noticeable.

(c) In experiment 16 ammonia vaporized by means of the Lentz apparatus was used at the end of 4 hours. Less ammonia was used and its neutralizing effect was far less than in experiment 8.

In table 3 it will be seen that a nearly complete disinfection (the tests used in this table largely show only surface disinfection) resulted.

II. DISINFECTION EXPERIMENTS WITH FORMALDEHYDE IN LABORATORY, BY W. L. GRAPP.

On Aug. 8, 1900, et seq., Mr. W. L. Grapp of Janesville, Minn., commenced certain investigations with formaldehyde in the State Board of Health Laboratory and Laboratory of Pathology and Bacteriology, University of Minnesota, in order to be able to make report to the embalmers' association at its meeting on September 4th. Mr. Grapp tried in his experiments an apparatus devised by himself and built under his direction, and the apparatus of Charles Lenz & Sons, and that of Parke, Davis & Co. Mr. Grapp's apparatus was constructed so as to permit of the rapid liberation of a large volume of the gas from a receiver in which the pressure had been rapidly raised by heat. A few suggestions relative to construction were given in the laboratory and acted upon by Mr. Grapp with resulting improvement in operation of the instrument.

The room selected for test was the basement room in which such inconstant results had been obtained in the experiments conducted in 1897 by Dr. George L. Gray.* This room is 11 feet high, 14 feet long, 10 feet wide and contains 1,540 cubic feet. The walls were of rough coat plaster on brick with the exception of one outside wall which was of cement on stone. Two doors and a window near the ceiling were rendered tight. The weather at the time was very wet. The gas was usually admitted through a hole bored in the window sash at a point about three feet from the ceiling. The test objects consisted of covership smears, dry threads and moist threads of *B. prodigiosus* and spore containing *B. subtilis*. *B. diphtheriae* was also used occasionally, and flies, spiders, bed bugs and moths were also exposed. The test objects were exposed on all occasions in three marked situations in the room, viz.:

(1) One foot from ceiling and about one foot from outside wall near the middle over the window and above the point of entrance of the gas.

(2) On stepladder in center of room about four feet from floor.

(3) On floor four feet from main door in inside corner of room and diagonally opposite to the second door.

Insufficient time was available for more than 11 careful tests. The results obtained were reported by Mr. Grapp to the embalmers' association, and may be briefly summarized as follows:

1. Constancy of results in killing all bacteria in test objects could not be secured with less than two pints of formalin (about

*Biennial report Minn. State Board of Health, 1897-98, pp. 146, 157 and 460.

20 ounces per 1,000 cubic feet) when the gas was forced in in 40 minutes and left in the room for 16 hours. Even then the bed bugs and moths were not killed, though flies and spiders sucsumbed.

2. Two pints of formalin (about 20 ounces per 1,000 cubic feet) forced into the room in 25 minutes and left for eight hours killed all but two of the test objects placed high and two which were low.

3. One pint (about 10 ounces per 1,000 cubic feet) forced into room in 23 minutes and left for eight hours failed to kill any of the bacteria or animals.

4. Three pints (about 30 ounces per 1,000 cubic feet) of formalin quickly forced into the room, even if left for only six to nine hours, killed everything.

CONCLUSIONS CONCERNING USE OF FORMALDEHYDE GAS.

From tests made of the efficiency of formaldehyde disinfection as ordinarily carried out in houses and also from careful experiments made in the laboratory or under direction of members of the laboratory staff, the following tentative conclusions seem warranted. Much has still to be done in supplementing the work of Dr. McDaniel, Dr. Gray and Mr. Grapp before publishing in detail.

1. Each disinfection really constitutes a research in which all variables must be considered.

2. Special selection of materials in a room requiring different degrees of disinfection is imperative since formaldehyde is in general terms only a surface disinfector.

3. The quantity of gas necessary for thorough disinfection is usually much greater than that specified by the manufacturer, even where the walls of the room are hard finished or painted and all cracks and openings are tightly closed. For cracks narrow strips of newspaper soaked in water will adhere long enough for the purpose without the necessity of pasting or gluing. This saves trouble and does not mar woodwork.

4. Concentration of gas is important. It is imperative that the gas be forced into the room quickly, therefore an apparatus which is capable of disinfecting a small room satisfactorily is not necessarily efficacious in a large room. A large apparatus or the use of two or more machines forcing gas in from various points is to be recommended for large rooms.

5. In rooms with very porous walls (rough plastered) much more gas, i. e., gas in greater concentration, is necessary than where the walls are hard finished or painted. In Mr. Grapp's experiments at least four times the amount of formaldehyde ordinarily recommended was found to be necessary in securing uniformity of results. This probably accounts for the conflicting results of Dr. Gray's experiments in the same room.

6. Bacteria and spores are more easily killed by formaldehyde when in or on moist objects, provided the air of the room is relatively dry.

7. Certain lower forms of animal life are sometimes more resistant to formaldehyde than are bacteria. This should be recognized and possible infection through the bites of vermin, mosquitoes, flies, etc., guarded against.

8. The boring of a hole through a window sash rather than the use of a keyhole or other aperture through a solid door is preferable as a point of entrance for the gas. In other words, it is preferable to be able to watch the gas as it emerges from the nozzle.

C. TESTING VARIOUS EMBALMING FLUIDS AS TO THEIR CAPACITY FOR RENDERING STERILE THE TISSUES OF HUMAN BODIES.

This work was begun at the request of the Minnesota Funeral Directors' Association, and has been carried on by the laboratory in collaboration with a special committee appointed by that association and with Dr. Chas. A. Erdman, professor of anatomy, University of Minnesota.

The object of the work has been to determine what fluid or fluids or mixtures were capable, after vessel and cavity injection, of producing complete disinfection of the body. Attention must necessarily be paid to cosmetic effects, a matter of considerable importance to embalmers. To be able to leave the body in a natural position and at the same time to permit of the necessary preliminary manipulations is also an essential which has complicated the investigation somewhat. The chief interest of the State Board of Health and therefore the work of the laboratory has been the determination of whether all micro-organisms in the body have been killed by the embalming. The investigation has been naturally subdivided as follows:

1. Furnishing of fluids and formulæ with practical suggestions regarding cosmetic effects by the committee of the Funeral Direc-

tors' Association. Individual members of the Association have made attempts to aid in the securing of the necessary material (cadavers) though lack of it has materially handicapped the work.

2. Mixing of various ingredients and vascular and cavity injection into the cadaver. This work has been under the charge of Dr. Erdmann. Full data has been preserved concerning the cause of death, time which elapsed between death and embalming with record of temperature and other conditions, state of nutrition, weight and appearance of body both before and after embalming, amount, composition and quantity of fluid used together with details as to methods employed in embalming and temperature, method of wrapping and other details of the keeping of the body after embalming until the time of testing.

3. The testing in the laboratory of the completeness of disinfection has been determined by taking cultures in various nutrient media from the pharynx, pleural cavity, pericardium, heart muscle, surface and also lumen of intestines, liver and spleen substance, subcutaneous fat and gluteal muscles. The surface of the body over these sites was sterilized by searing with a red-hot iron. The cultures have been kept under observation and when growth occurred, the morphology of the micro-organism has been noted.

RESULTS.

It has only been found possible to make 11 experiments, and therefore final report cannot be made at this time, but the following points may be mentioned:

(a) As ordinarily done embalming does not usually result in the death of all the bacteria in the body. (See also the case of acute febrile jaundice mentioned in this report, p. 495.)

(b) Certain of the embalming fluids containing carbolic acid or arsenic, or other metallic salts and which are perhaps preferable on account of the pliable state in which the body is left and because the color of the skin is fairly natural, do not kill all the contained bacteria even if several days be permitted to elapse after a most thorough and complete injection.

(c) Those fluids which contain relatively large percentages of formaldehyde (5 to 20 per cent) are most efficacious in producing sterilization of the tissues which in several instances has been absolute. On the other hand the cosmetic effects have been bad and there is little pliability of the tissues.

(d) The work at present consists of experimentation in the mixing of various ingredients, and it is hoped that something definite in the way of formulæ may be found which may be published and recommended by the Association. A circular of directions for use will, of course, be necessary. Should the researches be successful the State Board of Health will be in a position to make regulations governing methods and materials employed.

BACTERIOLOGICAL EXAMINATIONS OF MEAT, ETC.

These were universally unsatisfactory both to the persons sending the specimen and to the laboratory. In nearly every instance paucity or complete absence of essential data greatly hampered the investigation, and the method of collection and transmission of the specimens which frequently permitted of the entrance of saprophytic bacteria very greatly increased the labor.

As an illustration of the futility of laboratory investigation of material whose history, possible relation to disease and method of collection are unknown, perhaps no work reported during the period of 1899-1900 is more convincing than that of the examination of foods. For example, food and water are frequently suspected with very little or nothing in the way of evidence to show their connection with disease. People do not recognize that to examine a small piece of meat sent haphazard to the laboratory with a view of determining the fitness of the rest of the carcass for food, involves an expense of time and material to the state which amounts to far more than the value of many animals, with the great probability of obtaining at the end results upon which no positive opinion can be based.

Amongst the examinations made, the following may be noted:

1. *Hog Cholera bacilli in salt pork.* On Jan. 23, 1899, there was received for examination in the laboratory from Dr. R. F. Lynch, health officer of Monticello, Minn., a piece of salt pork about five inches square on the skin side and two and one-half inches thick. The following letter accompanied the specimen:

> I herewith send you a piece of salt pork taken from a barrel of salt pork in Mr. ————'s meat market in the village of Monticello. I used a portion of it for baked beans and it made me sick. I fried a portion and that made me sick.
>
> The slaughter house of Mr. ———— has been quarantined by the township board of health. Several days ago about 20 hogs died in the slaughter house. I desire a careful examination of this to determine if possible my stand to take in relation to meat killed in the slaughter house before quarantine by town board.
>
> R. F. LYNCH, M. D.

Coverslip preparations and cultures were made from the central portion of the meat removed aseptically.

The coverslip preparations and later the cultures also showed a very few sarcinæ and great numbers of small somewhat colon-like bacilli. The bacilli, when their cultural and biological characteristics were fully worked out, were positively identified as hog

cholera. They were compared with three other cultures of known hog cholera bacilli, and were found to be more virulent to laboratory animals than two of the stock cultures and slightly less so than the third.

This case is interesting. First, in that the bacilli were found deep in the body tissues where they had multiplied either before the death of the animal or after the introduction of the meat into the pickle barrel; and second, that the toxines were present in such an amount, and remained sufficiently unchanged in the presence of large quantities of sodium chloride and after cooking, that they were able apparently to cause nausea with vomiting and purging when the meat was eaten in comparatively small quantities by two healthy adults.

2. *Ulcer on Hog.—Relation to use of meat.* Feb. 13, 1899, a portion of meat, on the skin aspect of which was part of a healed ulcer on the back of a hog, was received in the laboratory from Butterfield, Minn. The sender requested that an examination be made to determine whether the rest of the carcass was fit for food. Nothing but *bacillus coli communis* was found, and further examination was not made.

3. *Meat condemned by St. Paul Board of Health.* The Minnesota State Board of Health was called in consultation by the St. Paul City Board of Health on April 20, 1899. Dr. Wilson visited St. Paul and collected specimens consisting of a mass of œdematous subcutaneous tissue from immediately above the knee and an enlarged retroperitoneal gland from each of four quarters of beef (eight specimens in all).

Direct smear preparations were stained in various ways and ærobic and anærobic cultures studied.

A full report was given, from which the following summary may be quoted:

"Neither in the smears nor in cultures made from any of the material were the bacilli of anthrax or symptomatic anthrax to be found, but the hæmorrhagic and degenerated condition of the lymph glands would seem to indicate that some disease had been present before death.

"The advanced state of decomposition of the connective tissue and glands when collected, as indicated by their macerated appearance, putrefactive odor and the enormous number of bacteria present in direct coverslip preparations, whilst obscuring the nature of the disease and rendering difficult or impossible an opinion as to its exact nature from a bacteriological standpoint, would certainly

condemn the meat as 'unfit for human food' at the time when it was examined.

"The absence of any data as to the nature of the disease in the cattle from which the meat was taken and the impossibility of making a satisfactory pathological study of the tissues on account of their condition when received is unfortunate."

4. *Supposed meat poisoning.* Lake Park, Minn., May 11, 1899. Specimen of ham was examined for bacteria, *trichina spiralis* and other microscopic evidence of possible cause of four cases of severe acute gastritis occurring in the practice of Dr. O. K. Winberg. No living bacteria could be demonstrated, and *trichina spiralis* was not found.

5. *Pre-vertebral glands in beef animal.* On Dec. 19, 1899, were received in the laboratory several reddish lymphatic glands from a cow for examination to determine fitness of the rest of the carcass for food. Failure of development of bacteria of any kind, together with the normal appearance of glands and meat, give no basis for an unfavorable opinion.

6 and 7. *Glanders bacilli in pork* could not be demonstrated in specimens forwarded from Lake Park on Dec. 28, 1899.

A specimen of pork forwarded on Jan. 8, 1900, from Twin Valley was also examined with negative results.

8. *Trichina spiralis in pork* was not demonstrated in specimens sent on Jan. 10, 1900, from Fairfax, Minn.

9. *B. typhosus in pork not found.* Specimens of pork were forwarded by the court in Winona on Feb. 5, 1900, for examination as to presence of *bacillus typhosus.* Careful examination showed only the presence of *bacillus coli communis.* It was pointed out that *bacillus typhosus* was not known to cause disease in swine, and that even in man the demonstration of it was difficult or impossible in most sites except the spleen, mesenteric glands or bowel or bladder contents, and that therefore negative findings in these specimens were entirely valueless.

10. *Pork (four specimens) and lard* were received from St. Cloud, Feb. 24, 1900, for examination as to disease in the animals from which they came.

Though an odor of decomposition was present and no care had been taken in packing or sending the specimens (loose in a cigar box), no growth of any bacteria could be obtained in cultures sown from the interiors of the pieces of pork and lard, the outside having been previously burned.

11. *Meat extract* received from Aitkin, Minn., through the food and dairy commission on June 4, 1900, was examined as to the presence of poisonous products or disease producing microbes by feeding to a cat, guinea pig and white rat. As none of the animals showed any untoward symptoms after being fed with many times (proportionately per body weight) the amount ordinarily used in making soups, broths and other dishes where beef extract is employed, it seemed unfair to assume that the sample submitted for examination had been responsible for the symptoms in the people who had partaken of it. Further examination seemed unnecessary, and the matter was reported to the food and dairy commission, by whose laboratory no mineral poison could be detected in the specimen.

12. *Beef examined for actinomyces.* Specimens of beef from Brewster, Minn., were examined on May 24, 1900, in order to ascertain whether the animals had been infected with actinomyces. The results were negative.

In reporting it was pointed out that the micro-organism is not general in its distribution in the body, and that upon negative results in the examination of beef, infection in other localities, such as jaw, tongue, glands of the neck, etc., could not be excluded.

13. *Mouldy bread and cattle disease.* Dr. R. Price, V. S., of St. Paul, brought to the laboratory a sample of bread, such as was fed to cattle amongst which an acute and fatal illness had developed. The results obtained by animal experimentation and cultural study were entirely negative. No opportunity for a study of the sick or dead cattle could be obtained.

INVESTIGATION OF SUNDRY OBSCURE DISEASES OF ANIMALS.

During the years 1899 and 1900 a number of examinations of specimens from animals dead of obscure—apparently infectious—diseases have been made with negative or inconclusive results. The demonstration of the relationship of bacteria — obtained post mortem—to the disease causing the death of an animal is peculiarly difficult in these isolated cases with obscure symptoms. The difficulty is frequently increased by the decomposed state of the tissue when received in the laboratory. Where specimens have been collected from any considerable number of animals recently dead of an infectious disease by a bacteriologist working

with a veterinarian—as in the cases of hæmorrhagic septicæmia, anthrax, meningitis, rabies, etc., herein reported, the results have been much more satisfactory.

Indeed, in investigating any unknown infectious disease of animals, too much stress cannot be laid upon the importance of the following points:

1. The symptoms should be studied at first hand by a competent veterinarian. The description of symptoms by laymen is frequently valueless, if not actually misleading.

2. Autopsies should be made before decomposition has begun. By preference the animal should be killed at the most favorable time—certainly before possible terminal infections are present to complicate the findings—and the autopsy made at once.

3. Autopsies should be made by a competent veterinarian and a trained bacteriologist. The latter should during the autopsy devote himself entirely to collecting specimens, making direct coverslip preparations, cultures, etc. A well equipped field bag is a *sine qui non* in this work, and, whatever else it may contain, should not lack an alcohol or gasoline blast lamp, platinum needles in metal handles, sterilized cotton swabs, and broth and serum (moist and capped) media.

4. Laboratory observations on morphological and cultural characteristics of bacteria isolated must be supplemented by inoculation experiments on animals of the same species as those from which the bacteria were originally obtained.

This important point presupposes the facilities on the part of the laboratory for obtaining and caring for several of each of the various farm animals. In this particular this laboratory has labored under great disadvantage. It is hoped that in the near future the defect may be remedied by the erection on the university campus of a suitable building for the care of large animals.

The following are the isolated cases of obscure—apparently infectious—diseases of various animals which have been investigated:

1. A spleen from a horse near Howard Lake, Minn., was received in the laboratory in a decomposed condition. A veterinarian had diagnosed obstruction of the bowels before death of the animal. Only *B. coli communis* was present in the spleen.

2. Examinations were made, 12 hours after death, of the bodies of three horses near North Branch, Minn. The history pointed to death by lightning, of which, however, no marks were

found. Decomposition was well advanced and the blood much disintegrated. Bacteriological examination showed various bacteria, probably putrefactive.

3. A portion of lung of a cow which had died of "malignant broncho pneumonia" was received in the laboratory in a decomposed condition. A bacteriological examination showed only putrefactive bacteria.

4. Near Forest Lake a post mortem examination was made on the body of a cow which had died 52 hours previously after exhibiting symptoms of severe acute diarrhœa. Decomposition was well advanced, and neither the autopsy nor the laboratory examination revealed the cause of death.

5. The heart and a portion of the lung of a buffalo, one of four dying within a short period on North Oaks Farm, Minn. The animals had died after very short periods of illness. The autopsy had been made by the farm superintendent who observed "The pleura congested in spots, blood thin, watery and imperfectly coagulated." The organs were decomposed and macerated when received. A large spore-bearing putrefactive bacillus and a small motile colon-like bacillus were present. No diagnosis was made.

6. A portion of the lung and the liver of a sheep from near Bruce, Minn., were received in the laboratory in a decomposed condition. Staphylococci and *B. coli communis* were found in both. No diagnosis was made.

7. The heart and lung of a bear which had died suddenly at Minnehaha Park, were examined in the laboratory with negative results.

8. The uterus of a Belgian hare which died, after aborting was examined in the laboratory without revealing the cause of the abortion (which had appeared to be infectious).

GLANDERS.

1. Two phials of pus from a case of supposed glanders near Duluth were received and examined in the laboratory. The decomposed condition of the specimens precluded the possibility of a diagnosis.

2. A phial of pus from an abscess formation in a gland at the angle of the jaw of a horse near Edgerton, Minn., were examined for *B. mallei*. *B. pyocyaneous* and a bacillus of the typhoid-colon group were isolated. Later it was found that a diseased tooth had been the exciting cause of the abscess formation.

HOG CHOLERA AND SWINE PLAGUE.

1. Portions of the lung and skin from two hogs slaughtered at Winona, Minn., were examined for hog cholera and swine plague bacilli. None were found.

2. Tissues from a hog dead of what appeared to be a sub-acute form of hog cholera, at the state experiment station, were examined in the laboratory, but no hog cholera or swine plague bacilli were isolated.

MALIGNANT CATARRH OF CATTLE.

Bacteriological examinations have been made of six head of cattle dying during an outbreak of malignant catarrh near Farmington, Minn. One of the animals showed no lesions—post mortem—of the disease, and no bacteria were found in cultures from the cranial sinuses. In the other five a short unevenly staining belted diplococcoid bacillus highly pathogenic for guinea pigs and rabbits was isolated from the cranial sinuses. Two other unidentified species of bacilli, as well as *B. coli communis* and staphylococci, were present in various organs of one to four of the animals. Further observations and experiments on cattle must be made before any definite conclusions are warranted as to the cause of the disease, though it would appear possible that the small, unevenly staining diplococcoid bacillus may have an ætiological relation thereto.

HÆMORRHAGIC SEPTICÆMIA

The results of the laboratory investigations on this serious infectious disease are reported in connection with the clinical and post mortem findings in the veterinary portion of this report. (See p. 351.)

SYMPTOMATIC ANTHRAX.

1. The heart of one calf and the spleens of three others dead of supposed symptomatic anthrax near Clear Lake, Minn., were examined in the laboratory. The animals had been dead 24 to 54 hours before the specimens were received, and were much decomposed. No bacilli of symptomatic anthrax were found in any of the specimens. (See also Hæmorrhagic Septicæmia, p. 374, this report.)

ANTHRAX.

1. An outbreak of anthrax was investigated during 1899 and 1900. This occurred on the farms of Mr. Kartrud and Mr. Iver O. Sathern, about nine miles north of Fergus Falls. The following is a history of the outbreak:

About the middle of July, 1899, Mr. Kartrud, whose place adjoins Mr. Sathern's on the south, lost two cows and one horse, all of which exhibited symptoms similar to those described further on. A bull belonging to Mr. Sathern broke down the intervening fence, and was for a day or two among the affected herd. Two weeks later this bull became sick and died, and within a few days three other cattle also died. A week or 10 days later six others became sick and died. On Thursday, September 7th a 15-year-old horse was worked and appeared well when stabled for the night. Friday morning he attempted to eat, but seemed unable to swallow. He was dead within two hours. Within the two weeks just previous to September 8th Mr. Sathern had also lost three hogs, which died very soon after he noticed that they refused food. The fourth also had been ill, but recovered. This was the only animal on the place which had been sick and recovered. His stock consisted of 46 head of cattle, 10 horses and 30 hogs.

Symptoms. (As described by owner.) Animals refused food. Appeared weak, trembling, and in a few cases slightly "crazy." They shook their heads as though in pain and walked stumblingly backward. Milk cows, shortly after becoming affected, gave no milk. One of the cows and the horse showed very marked swelling of the neck, reaching from the chest to the jaws. Two or three died with their heads and necks drawn violently backward. All had bloody discharges from the nose and bowels. All died within 48 hours from the time the first symptoms were observed, and several within four hours. The horse died within two hours.

Post mortem appearances. Mr. Sathern skinned two or three of the cattle which had died early. He said "the beef appeared as white and perfect as though the animal had been slaughtered for food." There was no blood under the skin, and there were no black marks on the meat. Two of the animals were observed by Dr. Holbrook, a veterinarian from Fergus Falls. The horse which died Friday morning, September 8, had been buried Friday evening. Saturday, September 9th, afternoon, Drs. Brimhall and Wilson exhumed and examined the head, neck and chest only of the

horse. On removing the skin from the chest and neck, a marked cellulitis was found present, the tissue being also black. Large dark-colored clots were found in the spinal canal, both within and without the dura. A large amount of cloudy fluid escaped from the spinal canal. A large quantity of similar fluid also escaped from the brain cavity when it was opened. A small amount of yellow plastic exudate appeared at the junction of the cerebrum and cerebellum at the median line. The vessels of the meninges were congested. The right and left ventricles of the cerebrum were filled with a quantity of cloudy fluid. Some small, dark-colored clots were also present. There was a marked inflammation at the base of the brain. The frontal sinuses were all filled with a dark bloody fluid. Cultures were taken from the subcutaneous tissue of the chest, fluid filling the fourth ventricle, from the surface of the cerebral meninges, from a deep portion of the cerebrum, and from the frontal sinuses. Tissue from similar areas was collected both for bacteriological study and in alcohol for histological examination. Fluid from the fourth ventricle, the right lateral and from two of the frontal sinuses was collected in sterile bulbs.

Some odor of putrefaction was present, but on the whole the preservation of the parts of the animal examined was good.

Bacteriological examination. Coverslip preparations. Direct coverslip preparations from the brain and from the fluid from the fourth ventricle, stained with methylene blue and by Gram's method, all showed a very few diplococci, and here and there a chain of large square-ended bacilli. Similar preparations from the fluid from the frontal sinuses and from the chest wall showed enormous numbers of short chains of streptococci, some diplococci (?), and in addition those from the frontal sinuses showed a few small bacilli and a few large bacilli like those from the brain.

Cultures. Cultures from the surface of the brain, and from the ventricular fluids, frontal sinuses and subcutaneous tissue of the chest were sown on serum, agar, and into plain broth. Those from the brain and ventricular fluids developed a few colonies of diplococci and many colonies of a bacillus designated as Bacillus "Y." (See description later.) Cultures from the frontal sinuses developed streptococci, a few diplococci (?), and small bacilli (B. coli communis?). Those from the chest wall developed many colonies of streptococci, a few small colon-like bacilli and "Bacillus Y."
"*Bacillus Y.*" The size and shape of bacillus anthracis, stains by

Gram and readily also with alkaline-methylene blue; is non-motile; grows fast at incubator temperature on the ordinary media and slowly at room temperature. *Serum:* 24-hour colonies are heavy, white, pasty with serrated borders. *Agar streaks:* 24 hours, broad, white, heavy with jagged outline. Twenty-four-hour *broth cultures* show woolly growth at the bottom of the tube which sticks together and is readily withdrawn. Body of fluid remains clear. Twenty-four-hour *potato cultures* are exactly the size, color and consistence of parallel cultures of *B. anthracis. Gelatine stick:* 24 hours, white thread; three days, fine lateral branches, slight liquefaction; six days, marked liquefaction, upper portion of liquified material clear; lower, clouded. *Gelatine plates*: 48 hours, pinhead, opaque colonies, white, irregular in outline and "woolly" in appearance under low power lens. Agar hanging drop cultures: most beautiful, "curled moss" patterns.

Pathogenesis. Guinea pigs inoculated subcutaneously with 0.2 to 2 c. c. of 24-hour broth cultures were killed in 36 to 40 hours. Post mortem showed intense œdema at the seat of inoculation, gelatinous appearance of subcutaneous connective tissue; spleen, dark, much enlarged and softened; small petechial hæmorrhages over peritoneum; heart filled with very dark blood.

Coverslip preparations showed the bacilli present in enormous numbers at the site of inoculation and in the spleen; also in smaller numbers in the peritoneal fluid and in the heart's blood. Cultures showed the bacilli recovered in pure culture from all the points named. Rabbits inoculated in similar doses as guinea pigs lived 40 to 50 hours. The autopsy findings were similar to those already noted in guinea pigs. Gray rats were killed in 24 to 30 hours with post mortem lesions similar to those noted above.

(An attempt was made to immunize rabbits with the anthrax vaccine provided by the Pasteur Institute, Chicago, for the purpose of control inoculations with "Bacillus Y," but the attempt failed, owing to the toxicity of the vaccine.)

It will be seen from the above that "Bacillus Y" is typical B. *anthracis*, and also that it is considerably more virulent than the ordinary laboratory stock cultures.

As soon as the identification of the organism was complete, a report was made to the secretary and to the director of the veterinary department of this board. Messrs. Kartrud and Sathern were immediately notified of the serious nature of the disease with which their animals were affected and instructed to take

more thorough hygienic measures than those already ordered. These instructions were carefully followed out by Mr. Sathern, but not by Mr. Kartrud. No other cases developed, however, until nearly a year later.

June 20, 1900, in the evening, Mr. Kartrud found dying on his place, a heifer and a cow. They seemed to be in great agony, and were bleeding from the nose and rectum. Both swelled up very much shortly after death. The heifer was buried just where she died, and the cow was dragged three or four hundred yards from the house and there buried. All other cattle on the place were supposed to have had a slight attack of the disease during the summer of 1899.

June 23, 1900, Drs. Brimhall and Wilson visited the Kartrud place and collected specimens:

Specimen "A." Earth from two inches below surface of grave of Kartrud cow, buried about 100 feet from the lake, July, 1899. There was no possibility of drainage from the grave to the lake, but an apparent favorite drinking place of the cattle, being at the point near the grave, specimen "B" was collected therefrom.

Specimen "B" consisted of earth and water from the shore of the lake near where the cattle had been drinking and quite near to the grave mentioned in specimen "A."

Specimen "C." Earth from several spots at a point where the heifer died on June 20th.

Specimen "D." Earth from grave and drag track of cow dead and buried June 20th.

Specimen "E." Earth from grave of Sathern cow buried on island about 75 feet from the lake shore, August, 1899.

Specimen "F." Water and earth from shore of lake at a point nearest the grave of cow mentioned in "E."

Explicit directions were again given Mr. Kartrud toward disinfecting by burning straw, etc. These directions he now followed out.

The specimens noted above were all carefully examined for anthrax bacilli, but, as was rather to be expected from their source, none were found.

In attempting to determine the avenue by which anthrax reached the farm of Mr. Kartrud in 1899, all inquiries failed to elicit any information which would give any possible clue to the matter. None of the animals had been off the place during the previous year, and no animals from elsewhere had been on the

place during that time. The only plausible hypothesis which could be formulated was that the crows, which nested in great numbers in the woods in which the cattle were pastured, might have carried thither, for their young, flesh of animals dead of anthrax. In this connection it is worthy of mention that several cases of anthrax had been reported in North Dakota during 1898 and 1899, about 30 or 40 miles west of Mr. Kartrud's farm. In addition in the spring of 1899 several animals had died on a farm about seven miles northwest of Mr. Kartrud's, of symptoms resembling anthrax. An autopsy had been made on the body of one of these animals by a local veterinarian, who said the disease was not anthrax. A farm laborer who had his hand cut while assisting at the autopsy, after a few days, developed symptoms of "blood poisoning" and died. The attending physician made an autopsy, diagnosed the case as anthrax, and had a microscopic examination made of tissue collected at the autopsy. Anthrax bacilli were reported present. It would thus appear probable that cases of anthrax in cattle had occurred but seven miles from the Kartrud farm some months before the outbreak on the latter, and it is conceivable that portions of the imperfectly destroyed carcasses might have been conveyed by crows to the Kartrud place and there caused the outbreak under consideration.

2. While on the trip to the Kartrud farm in 1900, Drs. Brimhall and Wilson visited also the farm of Mr. ——— Dahlberg, two miles southwest of Fergus Falls. Mr. Dahlberg had lost seven head of cattle suddenly five days previously. The carcasses had been destroyed. A specimen of water and earth was collected from near the shore of a small lake at a point where four animals had died and been skinned and buried. This specimen was carefully examined for anthrax bacilli, but none were found. The history of these cases was too vague to warrant any conjecture as to its real nature.

CEREBRO-SPINAL MENINGITIS.

A. IN SHEEP.

The brains, lungs, livers and spleens of two sheep belonging to Patrick Foley, of Glendale, dead Feb. 23, 1900, after exhibiting symptoms of meningitis, were examined bacteriologically with entirely negative results.

B. IN CATTLE.

1. The brain of a cow which died at the Experiment Station in June, 1900, showed marked meningitis and bacteriologically, gave a large diplococcus similar to, if not identical with, *diplococcus pneumoniae*, but mixed with other bacteria, since precautions had not been taken to prevent contamination during the removal of the specimen.

2. On Sept. 19, 1900, a two-year-old bull, the property of Judge Jamison, near Manitou Junction, Lake Minnetonka, appeared to be perfectly well in the morning, and an hour later developed symptoms of insanity, and died within a half hour. In the evening of the same day a four months' old calf went "crazy," and died within one-half hour after the first symptoms were observed. September 20th, in the afternoon, Dr. C. E. Cotton made a post mortem examination. No gross lesions of any kind were found in either animal, except hæmorrhages filling the sulci of the brain and a hæmorrhagic condition over the entire surface of the meninges. The brain was congested throughout. The lungs showed a hypostatic congestion. Specimens of a portion of the liver, spleen and one auricle of the heart in the calf were brought to the laboratory by Dr. Cotton, September 21st, at 4 p. m., in a glass fruit jar. The specimen was found to be much decomposed.

Bacteriological examination. Direct coverslip preparations stained with eosin and methylene blue from the liver showed large spore-bearing (probably putrefactive) bacilli; from the spleen and from the auricle of the heart.

Cultures. Sept. 23, 1900. Thirty-six-hour broth and serum cultures from the liver and spleen showed no growth; from the auricle of the heart, medium-sized bacilli (specimens had not been collected with aseptic precautions).

Sept. 21, 1900, at 6 p. m., another three-months'-old calf (No. 3) was found to be excited, bawling and in evident agony. The animal died within fifteen minutes after first appearing to be sick. September 22d, at 1 p. m., Dr. Cotton and Dr. Wilson made a post mortem examination of the animal. No gross lesions of any kind were encountered (barring hypostatic congestion of one lung), except within the brain. Here the meninges were most intensely congested. The subdural space was filled with blood serum. This was present also in the ventricles of the brain. Portions of the lung, liver, spleen and brain were removed in a sterile manner, and sent to the laboratory where direct coverslip preparations and cul-

tures were made. Sterile swabs were also inoculated from the same organs and from the heart's blood, and these, on their arrival at the laboratory, were used for inoculating serum and broth media.

Direct coverslip preparations, stained with eosin and methylene blue, from liver and spleen, showed large spore-bearing bacilli (probably putrefactive) and small bacilli (B. coli?). Those from the meninges and lungs in addition showed numerous diplococci. Cultures on serum and in broth were grown ærobically and anærobically in the incubator. Only B. coli developed in those from the liver and spleen. In those from the brain and lungs, B. coli and a large diplococcus developed. The diplococcus resembled in most respects that obtained from cases of meningitis in cattle and horses previously reported from this laboratory, and was presumably the causative factor.

3. At the State Experiment Station the following inoculation experiment was made by Drs. Reynolds and Wilson:

A black yearling Holstein steer, weight about 650 pounds; tested for tuberculosis twice during last three months; faint reaction at first; no reaction second time; animal apparently in good health. Friday, June 22, 1900, at 4 p. m., steer inoculated subdurally with 30 c. c. (except amount which escaped from trephine wound in dura—amount impossible to estimate) of equal parts of 72 and 24-hour plain broth cultures of diplococcus, original stock from brain of cow dead of meningitis, August, 1898, on farm of Anthony Welch, near Farmington, Minn. See report of Minnesota State Board of Health for 1895-1898, p. 180.

The animal developed within three days a high temperature, 105-7, which continued for three or four days, then rapidly subsided. Marked symptoms of meningitis were present, but the animal made a complete recovery.

C. IN HORSES.

1. On June 24, 1899, specimens were collected and brought to the laboratory by Dr. Wilson from two horses killed by Dr. Brimhall for purposes of autopsy when in the last stages of meningitis in an outbreak occurring near Herman, Minn., the clinical history and autopsy findings of which are reported by the director of the veterinary department.

The material received consisted of direct coverslip preparations and cultures made at the time of autopsy, and portions of

various organs of both animals examined, as well as from a fœtus in the mare.

Neither direct coverslip preparations nor cultures from any of the organs, except the central nervous system, showed any bacteria whatever. In both direct coverslip preparations and cultures from the brains of both mare and horse, but not from the fœtus, were found two organisms.

One was a large staphylococcus (?) extracellular, decolorizing by Gram's method, growing abundantly on the ordinary media, producing a small amount of acid in the various sugar solutions, developing no pigment on serum or potato, and producing no symptoms in rabbits, even when inoculated in very large doses, subdurally, intravenously and subcutaneously.

The other was a small diplococcus, somewhat lanceolate in shape, usually extracellular, but frequently intracellular, retaining the stain by Gram's method, and having the following cultural characteristics:

Plain broth—Faint diffuse growth.

Dunham's solution—Faint growth—no indol.

Capaldi-Proskauer's medium—Faint growth—acid.

Plain milk—No change after 72 hours.

Blood serum—Scattered colonies. One to two mm. in diameter, after three days. Heavy sowings, minute, colorless, discrete colonies.

Potato plates—No growth after 72 hours in the incubator.

Plain gelatine—Very faint growth after 72 hours at 22° C.

Litmus glucose gelatine—Very faint growth after 72 hours at 22° C. No change in color.

Plain agar—Very small, colorless transparent, discrete colonies.

Glycerine agar—Very small, colorless transparent, discrete colonies.

Litmus lactose agar—Very small, colorless transparent, discrete colonies. Faintly acid.

Litmus glucose agar—Very small, colorless transparent, discrete colonies. Markedly acid.

Litmus saccharose agar—Very small, colorless transparent, discrete colonies. Markedly acid and partly decolorized.

His' agar gelatine—Faint surface growth—not diffused at all.

The pathogenesis of the diplococcus has been tested as follows:

Rabbit No. 286—Inoculated subdurally and intravenously. Symptoms in 12 hours. Death in 24 hours. Meningitis. Recovery of organism pure from meninges alone.

Rabbit No. 287—Inoculated subcutaneously in groin. Death in seven days Meningitis. Marked inflammation of anterior mediastinal space. Recovery of organism from latter location only.

Rabbit No. 290—Inoculated subdurally. Marked symptoms of meningitis after 24 hours. Recovery.

Rabbit No. 291—Inoculated intravenously. Rise of temperature. Recovery.

Rabbit No. 292—Inoculated intrapleurally. No symptoms.

Rabbit No. 293—Inoculated intraperitoneally. No symptoms.

Guinea Pig No. 296—Inoculated subdurally. Marked symptoms of meningitis after 12 hours. Death after 4 days. Meningitis.

Guinea Pig No. 297—Inoculated intrapleurally. No symptoms.

Guinea Pig No. 298—Inoculated subcutaneously. No symptoms.

No opportunity of inoculating the organism in horses was obtained until in August, 1899, two months after the isolation of the diplococcus when a horse (No. 1) was inoculated subdurally at the Experiment Station, by Drs. Reynolds and Wilson. The animal showed a rise of temperature within the first 24 hours, but was unfortunately killed by some over-zealous humanitarian before the observations could be completed.

The accident and press of other work caused for a few days the laying aside of the organism, and, as a consequence, when afterward it was again inoculated into rabbits, the original virulence of the culture was found to be partially lost.

After waiting almost a year, two more horses were at last secured and inoculated as follows:

Horse No. 2. Small, old, bay broncho. Inoculated in left subdural space with 10 c. c. of a thick emulsion of 24-hour broth with five 24-hour serum cultures of the diplococcus originally from the brain of a horse dead of meningitis, near Herman, Minn. Inoculated at 5 p. m., May 23, 1900; at 8:15 p. m., the animal appeared excited, rushing about the stall, and trembling. A little later fell down. Temperature, 101.4. Found dead by attendant at 7 a. m. May 24th. Autopsy at 11 a. m., May 24th, by Drs. Annand and Wilson.

On removing a large plate of the parietal bone, the dura was found tightly stretched and bulging through aperture. Intense congestion of the membranes at point where fluid was ejected from the needle. At this point, also, the brain appeared softened (?). Subdural space contained a very large amount of cloudy, slightly bloody fluid.

Direct coverslip preparations and Löffler's serum cultures were made. Three bulbs of the fluid were collected aseptically. Also a portion of the cortex of the brain, in a sterile vessel and another portion placed directly in 96 per cent alcohol.

Direct coverslip and culture preparations all gave original diplococcus in purity. Many of the diplococci were within the leucocytes. They retained Gram's stain with great tenacity.

Horse No. 3. Very old. Tested with mallein, May 25, 1900 (?); no reaction. Inoculated into left carotid artery May 29th with

3.5 c. c. of 24- and 48-hour broth culture, emulsified with 24- and 48-hour serum culture of diplococcus of Herman meningitis stock, second culture from brain of horse No. 2.

Animal showed no symptoms up to and including June 15th, and remained well (no rise of temperature).

June 15, 1900, at 2:30 p. m., animal inoculated subcutaneously just back of left shoulder with 500 c. c. 48-hour plain broth culture of diplococcus from Herman meningitis stock "original." (Not passed through horse No. 2.) Also subcutaneously behind left shoulder with 500 c. c. 48-hour plain broth culture of diplococcus from Herman meningitis stock; third culture from horse No. 2.

Friday, June 22d, specimen of pus collected from abscess on left shoulder. Abscess had opened itself within the previous hour. Direct coverslip preparations showed abundant diplococci. No other microörganisms observed.

Cultures on Löffler's serum and on plain broth after 24 hours in incubator showed only diplococci present.

It would appear from these latter experiments on horses (a) that the organism is capable of producing meningitis and death very rapidly when injected subdurally; (b) that no effect is produced by a small dose intravenously, though it must be borne in mind that the animal's natural resistance may have been somewhat increased by the injection of mallein two days before the experiment; and (c) that local abscesses are produced by subcutaneous injections.

In conclusion, it will be seen from the above that the organism under investigation correseponds to *diploccocus pneumoniae—Frankel*— except that it does not coagulate milk, and when inoculated intravenously in rabbits, does not appear to multiply so abundantly in the blood, nor prove so rapidly fatal.

Since, however, it was found in the diseased meninges of both horses examined, and is capable of producing meningitis in both rabbits, guinea pigs and horses, the evidence is fairly conclusive that it was the cause of the epidemic under investigation.

2. The brain of a horse which died June, 1900, at the Experiment Station Hospital showed, macroscopically marked, meningitis and bacteriologically, a large diplococcus (probably a variety of *diplococcus pneumoniae*). Pressure of other work prevented the detailed study of this organism before it died out in cultures.

D. IN HUMAN BEINGS.

1. April 27, 1899, Dr. Day of Minneapolis brought to the laboratory the brain of a young woman dead five and a half hours previously after two weeks' illness, with symptoms of meningitis.

Meningitis was marked on the inner aspect of the frontal lobes of the cerebrum and at the occipital poles.

Staphyloccus pyogenes aureus and *diplococcus intracellularis meningitidis—Weichselbaum*—were found both in direct coverslip preparations and culturally from the under surface of the pia.

In view of the findings the question arises as to whether this was a sporadic case or only one in an unrecognized epidemic.

2. June 7, 1899, specimens from a child of nine years, dead after five weeks' illness with cerebro-spinal meningitis, were received from Dr. G. D. Haggard of Minneapolis, the attending physician. The autopsy had revealed the usual lesions of acute non-tubercular meningitis, but neither in direct coverslip preparations nor in cultures were found any bacteria of any kind.

3. June 21, 1899, there was received in the laboratory from Dr. I. D. Alger of Minneapolis specimens removed post mortem from the body of a young man dead after three weeks' illness with symptoms of meningitis. Direct coverslip preparations and cultures showed *diplococcus pneumoniae* present in large numbers. A portion of the lung and a phial of serum were also received, but were too badly preserved to admit of proper examination.

4. On Nov. 23, 1899, a specimen of cerebro-spinal fluid, removed by lumbar puncture from a child who had shown symptoms of meningitis for one week, was received from Dr. C. H. Hunter, Minneapolis. Cultures gave a few colonies each of streptococci and yellow staphylococci, and many colonies of *diplococcus intracellularis meningitis.*

5. The three specimens in this case consisted of cerebro-spinal fluid taken at intervals of a week during January, 1900, from a child 12 years old, under the care of Dr. C. H. Hunter. No bacteria were found either culturally or microscopically. At autopsy, a few days after the taking of the last specimen, a large brain tumor was found to have caused the patient's death.

6. In May a specimen of cerebro-spinal fluid removed on the ninth day of the disease, from a child 13 years of age, under the care of Dr. J. P. Barber, showed both in direct coverslip preparations and in cultures the *diplococcus pneumoniae* present in large numbers, and streptococcus in lesser numbers. The child died a few days later, but no autopsy was obtained.

RABIES (IN MAN AND VARIOUS ANIMALS).

During the years 1899 and 1900 eighteen (18) examinations have been made by the laboratory for the presence of rabies virus in materials from various sources.

Specimens have been received from 10 different localities in the state, and positive laboratory findings have confirmed the diagnosis of rabies in 14 of the 18 cases, which included one human being, four cows, one sheep, two hogs and six dogs. Owing to the decomposed condition of the specimens when received in the four remaining cases, i. e., two cows and two dogs, it was impossible to give a positive opinion.

The distribution of the cases was as follows:

TABLE NO. 4.

Bemidji	1 hog diagnosis, *rabies*.
Cottonwood	1 cow, specimen unsatisfactory, no diagnosis.
Good Thunder	1 cow, diagnosis, *rabies*.
Hugo	1 sheep, diagnosis, *rabies*.
Kerkhoven	1 dog, specimen unsatisfactory, no diagnosis.
Minneapolis	2 dogs, diagnosis, *rabies*.
Montevideo	4 cows, 3 diagnosed *rabies*; 1 unsatisfactory specimen.
	1 hog, diagnosis, *rabies*.
Princeton	1 dog, diagnosis, *rabies*.
St. Paul	1 human being, diagnosis, *rabies*.
	2 dogs, diagnosis, *rabies*.
	1 dog, no diagnosis possible.
Tracy	1 dog, diagnosis, *rabies*.

All of these cases, with the exception of one cow from Good Thunder, one hog from Bemidji, one dog from Minneapolis, and one dog from St. Paul are included in the 46 cases reported somewhat at length in a paper read before the Minnesota State Medical Society, Duluth, June 27th, 1900 (see p. 468, this report, and St. Paul Medical Journal, October, 1900). Further comment is therefore unnecessary, except in one case of some interest, in which rabies virus was demonstrated in milk.

*Rabies Virus in Milk.** On June 26, 1900, a small tightly corked glass bottle containing solidly coagulated milk was received in the laboratory. It had been forwarded by Dr. J. F. Schlesselman of Good Thunder, on June 22d, to the food and dairy commissioner, and by him to the office of the secretary of the State Board of

*This case was reported in discussion before the American Public Health Association, Indianapolis, Oct. 25, 1900. See Transactions American Public Health Association, 1900, p. 286.

Health. As it had been obtained from a cow 24 to 36 hours previous to her death from supposed rabies, it will be seen that more than five days had elapsed between its collection and receipt in the laboratory.

The following letter was immediately sent:

Minneapolis, Minn., June 26, 1900.

Dr. J. T. Schlesselman,

Good Thunder, Minn.,

Dear Doctor: Your letters to Commissioner Bowler and Dr. Bracken, were received this morning. The specimen of milk therein mentioned also came to hand. I fear that the milk has been so long in transit that it will contain so many microörganisms of various kinds that an inoculation under the dura of rabbits will kill them with meningitis before any symptoms of rabies could appear, that is, supposing the milk should contain rabies virus. We shall, however, make inoculations, though I imagine no diagnosis can be arrived at. If other cases occur, we shall be glad to make a diagnosis, if you will send us the material in the way specified in our Circular of Information and an additional circular on rabies, which I am sending under separate cover. It would be interesting, if further cases appear in cows, if you could send us some milk packed in ice so that it would reach us before the development of microörganisms takes place. Please furnish us with full data should you send us specimens.

Concerning the question of whether the milk of cows contains the virus before the development of symptoms, I cannot give you definite information, but the following points may be of interest:

1. It has been shown that the virus of rabies is present in secretions from the milk as well as certain other glands, when the disease has developed.

2. The virus of rabies is present in the *nervous system* of an inoculated animal even before the appearance of symptoms in that animal. To illustrate, we have inoculated, in this laboratory, rabbits (subdurally) with a fixed virus, that is, a virus which will always produce rabies in seven days. If such an inoculated animal be killed at any time between the time of inoculation and the appearance of symptoms, and its medulla used for subdural inoculations of other animals, rabies will be produced in the usual time of seven days.

3. It is therefore possible that the virus may be present in glands as well as the nervous system, even before the appearance of symptoms though the fact that in our experiments. inoculations were made subdurally must not be lost sight of in considering the appearance of the virus in the nervous system before symptoms ensued.

4. Most bacterial toxins, as well as snake poisons, are harmless when given by the stomach, due perhaps to the neutralizing effect of the liver and its secretions, since many of them can be neutralized by mixing them with fresh minced liver.

5. I do not know any recorded cases in which rabies followed the use of milk from a rabid animal. The absence of an abrasion in the mouth or mucous membrane, and the points mentioned above, would be a guide to you in the advice which you would like to give your patients.

We shall be glad to examine as many cases as you desire and to give any assistance in our power.

Yours very truly,

F. F. WESBROOK, Director.

The following table will serve to show the source of material used for inoculations, and the effect upon the rabbits used for experiment. These tabulated results, together with clinical observations and autopsy findings, would seem to indicate the presence of rabies virus in the milk. Though bacteria were very plentiful in the milk as it was received, they were not demonstrable in cultures made from any of the series of inoculated animals, except in three instances, to be accounted for by warm weather and death of the animals several hours before they were found on the following morning. In only one of these were bacteria found in the central nervous system or fluids, and on that occasion only a single colony of staphylococci developed. The colony was not visible until the third day. This suggests contamination, and does not therefore influence the results. No report was made to the physician at the time and it seemed better that none be made unless inquiry came from him. No answer or acknowledgment of the letter of June 26th was received. The chief interest of the investigation lay in the demonstration of rabies virus in the milk before the detection of symptoms in the cow.

TABLE NO. 5.

RABIES EXAMINATION NO. 47.

Rabbit No.	Weight in Grammes.	Source of Material Used for Inoculation.	Date of Inoculation.	Date of Death.	Time Elapsed Between Inoculation and Death.
369	1,000	Milk (sour) sent in by Dr. J. T. Schlesselman, Good Thunder, Minn.	June 26, 1900	July 28, 1900	32 days.
370	1,250			July 10, 1900	14 days.
371	1,570	Medulla of rabbit, No. 370.	July 10, 1900	Aug. 5, 1900	26 days.
372	1,380			Aug. 8, 1900	29 days.
375	1,110	Medulla of rabbit, No. 369.	July 28, 1900	Aug. 4, 1900	7 days.
376	1,410			Aug. 25, 1900	28 days.
377	670	Medulla of rabbit, No. 372.	Aug. 10, 1900	Aug. 20, 1900	10 days.
378	750				

RABIES IN MINNESOTA.*

BY F. F. WESBROOK, M. D.,

DIRECTOR OF STATE BOARD OF HEALTH BACTERIOLOGICAL LABORATORY AND PROFESSOR OF PATHOLOGY AND BACTERIOLOGY
UNIVERSITY OF MINNESOTA,
MINNEAPOLIS.

(From the Minnesota State Board of Health Bacteriological Laboratory.)

Within the past few years, attention has been called to the existence of rabies in this state. Whilst it is not probable that all of the cases, or perhaps even a majority of those reported in the press as rabies, are such, it must be recognized that many cases have occurred.

Station marked Bald Eagle on map should read HUGO.

Without any attempt at collection of all such cases reported and without any attempt even to collect statistics of those cases in which careful investigation by health officers, physicians and veter-

*Presented to the Minnesota State Medical Society at its 32nd Annual Meeting, Duluth, June 27, 1900.

inarians have led to probable or positive diagnosis of rabies, I desire to present a few points gleaned from the investigations of routine specimens in the laboratory of the Minnesota State Board of Health. The cases here included do not take into account many which have been investigated by the laboratories of the Health Departments of St. Paul and Minneapolis, except where the laboratory of the State Board of Health has been called in consultation. It seemed well, however, to try to gain some idea of the distribution of cases in which the diagnosis has been verified or made by laboratory investigation and of which data has been collected and preserved.

From October, 1896, to June 1, 1900, material has been received from 46 sources in this state for investigation as to a diagnosis of rabies. The following list will give some idea of the distribution of the cases from which the material came. The map on exhibition also shows these cases:

TABLE NO. 6.

St. Paul and vicinity,	13.	8 positive diagnoses.
Minneapolis and vicinity,	8.	5 positive diagnoses.
Montevideo,	5.	4 positive and the remaining one presumably rabies also, but specimen contaminated when received.
New Auburn,	1.	Positive diagnosis.
New Market,	1.	Positive diagnosis.
Benson,	1.	Positive diagnosis.
Mora,	2.	Positive diagnoses.
Maryville [Wright Co.]	2.	Positive diagnoses.
Cottonwood,	1.	Specimen contaminated when received.
*Hugo,	1.	Positive diagnosis.
Princeton,	1.	Specimen contaminated when received.
Cannon Falls	1.	Positive diagnosis.
Adrian	2.	Positive diagnoses.
Hastings	1.	Specimen contaminated when received.
Faribault	1.	Positive diagnosis.
Willmar	1.	Specimen contaminated but subsequent history that undoubtedly of rabies.
Raymond	1.	Positive diagnosis.
Rosemount, 6 cases,	1.	Negative. Pneumococcus meningitis.
Zumbrota	1.	Positive diagnosis.
Kerkhoven	1.	Specimen contaminated when received.

Of these 46 cases, in 31 it was possible to give a positive diagnosis by means of observation upon laboratory animals which had

*On map marked as Bald Eagle.

been inoculated subdurally with emulsions of the brain, medulla or cord of the human beings or animals examined. In the remaining 15 cases, the laboratory examination showed:

One case of diphtheritic meningitis in a human being.

One case, meningitis due to mixed pneumococcus and pneumobacillus in human being.

One case in human being, not rabies, but cause of death could not be determined from specimens submitted. Inoculation of material was without effect on animals, and when received, material was in a condition which precluded the possibility of its satisfactory examination for microscopic or other lesions.

One case in cow of diplococcus meningitis.

Two cases in dogs where rabies could be excluded through nonvirulence of subdural inoculation into rabbits.

Six cases in which the material when received was too far decomposed to be used for inoculation, or when used for inoculation produced meningitis and death before infection by rabies had time to develop.

Two cases in which the laboratory findings were confusing and rabies could neither be excluded nor established. In both of these cases the findings were such as to indicate bacterial contamination, though it could not be demonstrated. Some delay had occurred in the transit of the specimens.

One case of a dog which was bitten by a supposedly rabid animal was kept for several months in the laboratory and not having shown any symptoms was restored to his owner.

These cases have been distributed as follows:

Human beings—Four cases. Of these cases in one only was the diagnosis of rabies substantiated by laboratory findings. One case was shown to be diphtheritic meningitis,* reported by Drs. Head and Wilson, in the Journal of Experimental Medicine, vol. IV., Nos. 3 and 4, 1899, and one was a meningitis due to diplococcus pneumoniae and diplococcus of Friedlander mixed. In the fourth case, it was impossible to determine cause of death. The material was without effect when inoculated into rabbits and was unsuitable for histological or other study.

Dogs—Thirty cases. Of these, 16 were described as having furious rabies. In the others, the disease was of the mute variety, or undescribed.

On these cases, positive laboratory reports were given in 20.

*See also this Report, p. 557.

used for inoculation or killed the rabbits with meningitis. In three, rabies was excluded. In two cases, the examination was unsatisfactory.

Cattle—Eight cases. In these animals the diagnosis of rabies was made in six cases upon laboratory findings. In one case, owing to delay in receiving the specimen, bacteria had developed and the rabbits which were inoculated from the brain of the cow, died in two days. The diagnosis of rabies is probable, however, since four other animals (three cows and a pig) from the same farm and presumably infected through the same channel gave positive laboratory findings. The remaining animal, one of the six similarly affected, was shown to have been infected with a diplococcus similar in all respects to the pneumococcus so far as yet studied. The clinical symptoms and post mortem findings too, were those of meningitis.

Horses—One case. This was a case of furious rabies in a pony in which the diagnosis was confirmed by laboratory findings. The case occurred in St. Anthony Park, and was studied in collaboration with Dr. M. H. Reynolds.

Pigs—One case. This case was one of a series at Montevideo, and will be referred to later. The laboratory diagnosis of rabies was given.

Sheep—One case. This case occurred at Hugo, Minn.,* and was one of a number affected. Dogs, cattle and pigs in the same vicinity had been suffering from apparently the same disease.

Wolves—One case. This occurred near Cannon Falls and the furious animal (prairie wolf) attacked several people and bit three. These three persons were given the Pasteur treatment. The rabies virus obtained from this source was very strong and was carried through twelve sets of animals. The people have not, however developed symptoms.

As illustrating the occurrence and spread of this disease, the following outbreak may be mentioned:

CASES AT MONTEVIDEO, MINN.

Tuesday, Sept. 25, 1899, Mr. W., Sr., came into the laboratory and gave in part the following history of the outbreak:

About August 15th, a bitch in the possession of G. S. W. (son of the relator, and living on his father's farm about five miles east of

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*On map shown as Bald Eagle.

Montevideo), had a fight with a skunk as evidenced by the odor and a wound on the lower eyelid. Nothing was thought of the incident. until about two weeks later when the bitch began to act strangely. She ran away from home several times, snapped at persons and various farm animals, including her two pups, and showed an inclination to creep away into retired corners. After two days' of these actions, she was tied up, and died two days later, having become paralyzed, first behind. She tried to eat and drink from the beginning of her sickness but seemed to be unable to swallow readily. Toward the last she was very weak and could neither eat nor drink.

Two pups about two months old were bitten by the bitch, their mother, while she was sick. About two weeks later, they began to show symptoms similar to those exhibited by the mother, and died after a few days of illness.

About September 15th, or two weeks after the death of the bitch, a calf, a cow, and a cat were taken sick and died within two days. None of these animals had been seen to be bitten by any of the dogs, however. On September 20th, another cow, which had been bitten on the nose by the bitch (this was observed, not conjectured), became sick and died Monday evening, September 25th. The cows and calf, after appearing perfectly well the day before, would stop in the pasture and begin bellowing in a frightened manner until exhausted. They refused food and drink. They seemed to pay little attention to people, but when small animals, as calves, or particularly chickens, came in their neighborhood, they chased them. They gradually became weak behind, lay down with their heads drawn back, showed considerable escape of fluid from the mouth, and finally died apparently from increasing paralysis. Their excitement on the approach of chickens continued until their death.

On Friday, September 22d, while Mr. W., Sr., was attempting to give medicine to a cow which had been sick two days, he scratched the back of his hand on one of her teeth, making a wound one-half an inch long and deep enough to draw blood. He washed his hands afterwards, and the next day had his physician in town clean the wound and put on a collodion dressing. On the advice of his local physician, Mr. W. came to this laboratory, where, after hearing the previously given history of the case, he was advised to go to a Pasteur institute. Dr. Bracken gave him letters of introduction to the officials of the institute selected by Mr. W. who left on the same evening.

Mr. W. lost more cattle at this time, and though the first specimen (cow's head) was so delayed in reaching the laboratory that putrefactive and other bacteria had developed to such an extent as to cause death of inoculated rabbits in two days, the investigation of the other animals led to a positive laboratory diagnosis. Mr. W. was entirely well when last heard from in February, 1900.

After a lapse of three months, the disease broke out again and two more cattle succumbed. From one of these, material was received in the laboratory, and upon its examination a diagnosis of rabies was given.

The history here seems complete, and a series of animals, including three dogs, one cat, one pig and eight cows on one farm, all developed symptoms of rabies and died or were killed.

THE METHOD USED FOR DIAGNOSIS AND FACTORS WHICH INTERFERE WITH ITS SUCCESS.

A portion of the brain, cord, or by preference medulla, of the animal suspected of rabies is rubbed up and emulsified in sterile broth or salt solution. Two rabbits are trephined in a surgically clean manner and by means of a sterile hypodermic syringe, 0.1 to 0.5 c. c. of the suspension of cord, brain or medulla is injected beneath the dura. This necessarily presupposes the arrival in the laboratory of the suspected material, if possible without any bacterial, contamination, if not, at least without opportunity for the increase of any bacteria which have accidentally gained access to the surface of such material.

Notwithstanding the possibilities which have existed for contamination, it is somewhat surprising to note the possibilities of arriving at a correct diagnosis. To illustrate this, the following cases may be cited:

CASE IN A SHEEP AT HUGO, MINN.

In this instance, the material was collected by a member of the laboratory staff, Dr. L. B. Wilson. The greatest care was taken and the full traveling equipment used, but the cultures from the cerebral fluids and tissues were found to develop a diplococcus which upon inoculation was virulent for rabbits in 11 to 15 days, causing in some pus formation and septicaemia. From the medulla of the sheep, two rabbits inoculated subdurally, died in 17 days. The diplococci were not found in cultures from their brains or organs, and rabbits inoculated with an emulsion of the medulla of

one of the animals, died in 26 and 13 days respectively. The symptoms and autopsy findings were characteristic of rabies and the absence of bacteria corroborated this diagnosis.

Presumably the cocci were present in such small numbers in the material used for inoculation as to have produced no symptoms, and that they had died out in the bodies of the rabbits would seem to have been established by the failure to obtain them in any of the cultures. In this case, then, in spite of the demonstration culturally of a pathogenic diplococcus in the material, it was possible to establish a diagnosis of rabies. The sheep had a purulent wound in the scrotum supposedly made by the rabid dog to which its infection was attributed and it is of course possible that this was a case of mixed infection, rabies and pneumococcus septicaemia and meningitis, though it would be perhaps more reasonable to suppose that the presence of the diplococcus was an accident in technique. In this outbreak, there was the history of the infection of two dogs, six sheep and two cattle on one farm and of one dog and several other animals on another.

CASE IN HUMAN BEING AT ST. PAUL.

A case of human rabies in St. Paul, also illustrates this possibility. There was received in the laboratory on April 2, 1900, a test tube containing a portion of the spinal cord of a boy, Christ. Bucka, who died some time after vaccination by a St. Paul physican. The history of the case has not yet been furnished us by the St. Paul Board of Health,* but I believe there was the history of a bite of a dog several months before. The patient had been vaccinated some few days before death. The material had been two days in transit (Sunday intervened) and upon immediate microscopic examination showed diplococci and diplobacilli, which on further histological and cultural study, as well as investigation as to pathogenesis, proved to be the diplococcus of pneumonia and Friedlanders' diplobacillus. In making the preliminary inoculations, four rabbits were used. To two of them the emulsion of the cord was given subdurally in the ordinary manner; to the other two was given an emulsion of the cord in antipneumococcic serum, and also a subcutaneous injection of the serum in order to neutralize the pneumococcus and give the rabies virus an opportunity to act. The first two rabbits died in 22 and 14 days respectively, though

*Vide St. Paul Medical Journal, August, 1900, p. 550.

they showed symptoms of meningitis inside a few hours and their death was expected hourly for some days. On autopsy, they showed some cerebral congestion, but bacteria of any kind were absent.

A pair of rabbits inoculated from one of these developed symptoms of rabies (not meningitis) and died in 37 and 45 days respectively. Neither in the tissues of these animals nor in the material with which they had been inoculated could any bacteria of any kind be found in cultures or on microscopic examination.

The diagnosis of rabies would seem to be established by the appearance of rabic symptoms in the second series of rabbits and their death in the time noted. The symptoms in these rabbits were markedly different from those in the first series inoculated directly from the cord of the patient. It is probable that the rabbits of the first series developed a meningitis due to the diplobacilli and diplococci from which they were recovering when the rabies virus killed them. This is rendered more likely when it is remembered that no microörganisms were found in cultures made from their tissues, as was the case also in the second pair.

Of the two animals inoculated with the emulsion of the boy's brain and antipneumococcus serum, one died in two days, having developed symptoms of meningitis within the first 24 hours. Autopsy at once, showed some clear fluid at site of inoculation (extradural). Considerable congestion of meninges. Pericardium distended with clear fluid. No other gross lesions. Direct smears were made from the site of inoculation (extradural), from the surface of the brain and from the pericardial fluid and heart's blood. No bacteria were found in either smear preparations or cultures from the external wound or from the pericardial fluid.

From the surface of the brain, both in smears and in cultures, both the diplococcus and diplobacillus were obtained in abundance. In the heart's blood the microscopic examination of stained smear preparations showed no bacteria of any kind though cultures gave a growth of the diplobacillus. In this case the antipneumococcic serum had no effect in the arrest of symptoms which developed very quickly and the findings above noted would point to a meningitis due to mixed infection of both organisms originally found and a septicaemia due simply to one of the two organisms (diplobacillus). Perhaps the antipneumococcic serum may be credited with the limitation of the pneumococcus to the brain and the prevention of its entrance into the general circulation.

The second rabbit which was inoculated with the emulsion of the patient's cord and antipneumococcic serum differed from the other three inoculated at the same time in that it did not at any time show symptoms of meningitis. This animal developed symptoms of rabies and died in 22 days. From its medulla, brain, tissues and blood, no bacteria of any kind were obtained. From its medulla two other rabbits were inoculated and these developed symptoms of rabies and died in 25 and 23 days respectively.

As stated above, the history of the case, autopsy findings, etc., are not in the possession of the laboratory as yet, but the diagnosis of rabies seems well established and the presence of the microörganisms found was presumably simply a contamination impossible to avoid and due largely to delay in transit of the specimens. The laboratory of the St. Paul Board of Health gave a diagnosis of rabies and did not find bacteria of any kind in the fresh specimens which were received some two days before those in this laboratory. The examination was most satisfactory since the physician's reputation had been more or less jeopardized and the dangers of vaccination pointed out.

The above cases serve to show how it is sometimes possible to obviate or overcome the difficulties which are incident to a fault or accident in the technique of collection and transmission of specimens. The material in these two cases was collected by skilled and careful bacteriologists so that when it comes to the forwarding of specimens from country districts where laboratory facilities are not available, the simpler the technique, the better. It was with this particularly in view that the State Board of Health circular was prepared.

When the specimens are received in the laboratory, immediate inoculation is necessary, and though the material is always examined culturally and bacteriologically, it frequently happens that bacterial contamination cannot be discovered until the lapse of a few hours, when it is, of course, impossible to protect the already inoculated animals against the bacteria present and permit the rabies virus, if present, opportunity to develop. Nor is it possible to protect against many of the organisms which may be present could their presence be determined in time. Cases have occurred in the experience of the laboratory where meningitis developed and the inoculated rabbits have died in a few hours. Streptococci, diplococci, staphylococci and bacilli have been found both in the original tissues and inoculated animals.

It is impossible to know in such cases whether:

(a) The disease in the supposedly rabid animal was meningitis;

(b) Mixed infection, i. e., rabies and meningitis;

(c) Rabies alone and the microbes present due merely to contamination; or

(d) The symptoms in the original animal neither due to meningitis nor rabies and the microbes present as the result of accidental contamination.

Where the material is collected by a skilled bacteriologist, brought immediately to the laboratory and immediate investigation made, these points may be determined. This is nicely illustrated by the work reported from the laboratory by Drs. Head and Wilson, upon a case of diphtheritic meningitis simulating rabies. The case (human) gave in clinical history, autopsy findings, etc., a very good picture of rabies in most respects but by careful work, rabies was excluded and as diphtheria bacilli were found on culture and in microscopic specimens of the fluids and tissues of the brain, a diagnosis of diphtheritic meningitis could be given. It is a most interesting case, is unique (the first of the kind reported), and the work upon it was complete in each detail.

Conclusion. It is very evident that rabies does exist in this state, and is fairly widespread in distribution and number of cases. The cases examined, and which proved to be rabies, include one human being, twenty dogs, one horse, seven cattle, one pig, one sheep and one wolf. We have histories which show that infection was known to be due in these cases to the bites of nineteen different dogs, and perhaps one skunk, in which rabies infection may be assumed from the demonstration of rabies virus in the cases bitten by them. We have also data which shows that at the time of the infection of the cases investigated by the laboratory, one man, eight dogs, eight cattle, six swine and six sheep were known to have been bitten, and of these eight cattle, six swine, six sheep and three dogs died of rabies. That is, all of the cattle, swine and sheep developed rabies. The man received Pasteur treatment.

The animals which were thus shown to have had rabies on laboratory investigation are known to have bitten seven human beings, three dogs, six cattle, one horse and five hogs. Of these, five of the people received Pasteur treatment, and none, so far as is known, developed rabies. Of the animals bitten, five cattle, one horse, one hog and four dogs, developed rabies, and died or were killed. Many more of the dogs known to have been bitten were killed before

rabies had a chance to develop. As an example, it may be mentioned that in Willmar thirty were killed at one time. These estimates have been carefully made, and where the information at hand stated that several animals were bitten, account was taken only of one.

It will therefore be seen that from these 46 cases examined, of which 31 were shown to be rabies and concerning which there was data in only a small portion of the cases, we have been able to obtain positive knowledge of 84 cases of rabies in this state. (See table below.)

TABLE NO. 7.

	Human Beings.	Horses.	Cattle.	Sheep.	Swine.	Dogs.	Wolves.	Total.
Rabies diagnosed by Laboratory Minnesota State Board of Health	1	1	6	1	1	20	1	31
Animals which bit the animals shown by the Laboratory to be rabid						19		19
Animals which developed rabies and died from bites inflicted under the same circumstances as those animals which were shown to be rabid by laboratory investigation			8	6	6	3		23
Animals which developed rabies after having been bitten by animals shown by the Laboratory to be rabid		1	5		1	4		11
Total	1	2	19	7	8	46	1	84

To Richard Price, V. S., of St. Paul, is due the credit of early and persistently calling attention to the presence of rabies in this state. Its presence should and must be recognized, and steps taken to prevent its spread. To do this, accurate diagnoses should be made, and for this purpose the laboratory must be called in to help in doubtful cases.

To secure satisfactory laboratory examination the specimens and data must be properly collected and forwarded. In the laboratory technique it is well to insist upon the employment of a series of at least two sets of animals (2 in each set) for inoculation, so that should contaminating microbes be found an opportunity for their disappearance and for the development of rabies infection may be afforded in the second set of animals.

In order that the disease may be combated and suppressed, physicians must act as public educators, and the facts as set forth in the Circular of Information on Rabies, issued by the State Board of Health, may be useful to this end.

(The special rabies circular was prepared at the order of the Board by the Secretary and the Director of the laboratory and issued from the Secretary's office Aug. 15, 1899. It was presented before the meeting of the State Medical Society for criticism and suggestion.)

SUNDRY BACTERIOLOGICAL INVESTIGATIONS OF SEPTIC PROCESSSES IN HUMAN BEINGS.

I. SEPTICAEMIA.

(1). Pus from an incised lymphatic gland in the axilla was examined May 5, 1899, and found to be due to unmixed streptococcus infection. The septic condition occurred in one of the university staff, as the result of a wound made during autopsy on a septic case.

(2) HAEMORRHAGIC SEPTICAEMIA (STREPTOCOCCUS).

An interesting case occurred in the practice of Dr. C. O. Cooley, H. O., of Madelia, Minn. The infection had taken place through an abrasion made on the back of the man's hand by a rope used in the barn. The development of a rapidly fatal, hæmorrhagic septicæmia, and the means of infection suggested the possibility of infection with the bacillus of anthrax, symptomatic anthrax or of hæmorrhagic septicæmia on account of the fact that several fatal cases of obscure cattle disease were occurring in the neighborhood. Dr. Wilson, of this laboratory, visited Madelia, and together with Dr. Cooley made an autopsy on Nov. 2, 1900, 11½ hours after death. The almost diffluent condition of the spleen, the hæmorrhagic areas in the subcutaneous tissues and lungs, and the parenchymatous degeneration in liver and kidneys were the most marked lesions.

The tissues were placed in sterile receptacles, packed in ice, and forwarded by express to the laboratory, and within 24 hours the presence of a streptococcus unmixed with other organisms in the spleen and kidney and contaminated by various other bacteria in lung and liver was reported to Dr. Cooley.

(3) STREPTOCOCCUS INFECTION IN DIPHTHERIA (FATAL).

In a fatal case (child) of diphtheria which occurred in Minneapolis in the early winter of 1900, antitoxin had been administered early, and again repeated until 20,000 units had been given, with no apparent benefit. The presence of a streptococcus, which proved very virulent for animals, and which was far more abundant than the diphtheria bacilli, helped to explain the situation.

(4) PUERPERAL SEPTICAEMIA.

But one investigation was made. The results were unsatisfactory and valueless, owing to the decomposition of the material (uterine scrapings) when received. Delay had occurred in transmission, and no attempt had been made at proper precautions in collection.

II. CELLULITIS IN A BUTCHER.

On Sept. 19, 1900, was received from Dr. J. C. Stewart, of Minneapolis, a gauze dressing from a butcher, who infected his hand whilst cutting meat. The infection was slow in development, but extended to the elbow, in spite of vigorous treatment and free incision. The bacteria obtained were staphylococcus pyogenes albus and a gas-producing diplo-bacillus, somewhat resembling Friedlander's diplo-bacillus. The reason for investigation was the history of possible infection from diseased meat.

III. OSTEOMYELITIS.

1. Case 1, May 13, 1899—Pure culture of streptococcus obtained.
2. Case 2, June 8, 1899—Pure streptococcus, short chains.

IV. ENDOCARDITIS.

During the second quarter of 1900 two somewhat obscure cases of endocarditis occurred, and the heart's blood and vegetation from valves were examined with negative results.

V. SMALLPOX PUSTULE.

On Jan. 20, 1900, a physician sent to the laboratory, on swabs, pus from an eruptive process on the skin of a child recovering from typhoid fever. Staphylococcus pyogenes aureus was the only micro-organism demonstrable, and on the next day smallpox was diagnosed. The examination had been undertaken in order to ascertain if bacillus typhosus was responsible for the pus production, and was therefore discontinued.

VI. PLEURITIC FLUID.

Three specimens were examined, which showed pus cocci in coverslip preparations and cultures. Tubercle bacilli were not demonstrable by guinea pig inoculation.

TETANUS.

Case 1. On July 17, 1899, there was received in the laboratory in a sterile Petri dish, several lots of tissue from the original wound in the palm of the hand of a man who afterwards died of undoubted tetanus. The case was apparently infected by gunpowder explosions on July 4th. The case occurred in the practice of Dr. M. R. Wilcox, and was operated on at St. Mary's Hospital, Minneapolis.

Direct coverslip preparations and careful anærobic cultures and animal inoculations with pieces of tissue were made, but all gave negative results.

Case 2. On Aug. 17, 1899, there were received in the laboratory the two fingers of the hand of a man who afterward died of tetanus. The case had been operated on at St. Barnabas Hospital, Minneapolis, by Dr. Benjamin.

Anærobic cultures from this material gave an organism, which morphologically is not to be distinguished from the bacillus of tetanus, but which presents no degree of virulence to laboratory animals. On the hypothesis that the virulence may have been destroyed by some manipulation, after its removal from the body, effort was made to restore, if possible, lost virulence. It had been intended to mix with it virulent tetanus toxin, inoculate guinea pigs with the mixture and attempt to isolate the micro-organism again from the site of inoculation, but through misadventure it was lost.

Case 3. From an autopsy held by Dr. G. D. Haggard, on a patient in the care of Dr. P. M. Hall, of Minneapolis, specimens were brought to the laboratory by Mr. J. M. Ferguson on Aug. 28, 1900.

History of the case was injury to sole of the foot, which promptly healed. With onset of symptoms, the site of the wound was opened and a chicken bone removed. Death occurred within a short time after onset of symptoms of tetanus. Complete history and autopsy findings were not received.

Cultures were made and examined as follows:

(a)—Surface of brain Aerobic—no growth.
Anærobic—no growth.

(b)—Pericardium Aerobic—Two colonies of staphylococcus after four days.
Anærobic—no growth.

(c)—Ventricle of brain	Aerobic—diplococcus and staphylococcus. Anærobic—diplococcus.
(d)—Heart's Blood	Aerobic—diplococcus and staphylococcuc. Anærobic—diplococcus and staphylococcus.
(e)—Site of Inoculation	Aerobic—diplococcus, staphylococcus and B. coli communis. Anærobic — staphylococcus, diplococcus and streptococcus (?).

Nothing resembling the tetanus bacillus could be discovered, even though a large amount of tissue was taken for the anærobic cultures. Sub-cultures made from these when they were 48 hours old were immediately heated to 80° C for one-half hour, and on incubation in an atmosphere of hydrogen remained sterile. This showed absence of *B. tetani* in the cultures.

This case would seem to be probably one of septicæmia and meningitis, though it must be confessed that failure to find B. *tetani* cannot be taken as absolute evidence of the absence of tetanus infection. No tissues except site of inoculation were available for study.

Case 4. The materials for this case consisted of diphtheria swabs infected from the site of inoculation, as well as site of inoculation itself. The case occurred in a patient of Dr. Eitel's, and was brought to the laboratory by Dr. Taylor. The specimens were received Aug. 28, 1900. No other pathological material was received.

A diplococcus and bacillus (coli communis) were discovered, and nothing resembling B. *tetani* could be observed. Owing to inability to study the tissues, and in the absence of full data, no opinion as to nature of the disease could be vouchsafed.

DYSENTERY.

1. Case of a returned Philippine soldier in St. Barnabas Hospital, March 3, 1900. The specimen received was dried on a swab and amœba coli was not demonstrated. Pure cultures of bacillus coli communis were alone found.

2. Two cases infected presumably at Hot Springs, Ark., were investigated in December, 1900. In the fæces from one of them,

amœba coli was demonstrated, and from the two a number of strains of bacilli seemingly related to bacillus typhosus, and bacillus coli communis were obtained. The different strains show minor, though apparently fixed differences, in their reactions to the various sugars, so far as gas and acid production are concerned. In one of the cases no typical strain of bacillus coli communis could be found. They are at present under investigation.

DYSENTERY AND GENERAL INFECTION DUE TO BACILLUS PYOCYANEUS.*

Sept. 14, 1900, two specimens of stools were received from a case of dysentery. The patient, a girl of six years, had been ill for some weeks with severe diarrhœa and general irritability of gastro intestinal tract. Ulcers were present in the lower bowels, and the discharges were bloody and contained shreds at times. Weakness and emaciation were profound.

Laboratory examination by plates and subcultures from isolated colonies showed only two kinds of bacteria, viz., bacillus coli communis and bacillus pyocyaneus. Later specimens on Sept. 25, 1900, gave similar results. Although there seemed to be more or less general infection, and even broncho-pneumonia, the patient gradually recovered. This would seem to have been a case of infection with bacillus pyocyaneus.

CHOLERA INFANTUM THOUGHT TO BE DUE TO B. DIPHTHERIAE.

On Sept. 15 and Sept. 18, 1900, serum cultures (nine in all) were received for examination, as to the presence of *B. diphtheriae*, since much diphtheria existed in the town at the time, and portions of false membrane were present in the lower bowel.

A most careful search failed to show any other micro-organism than bacillus coli communis.

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*Since this was written, Dr. W. E. Harwood, of Eveleth, Minn., has published a complete history of the case. See Chicago Medical Recorder, Vol. XXI., No. 2, p. 115.

The Widal reaction of the patient's blood was tested with bacillus typhosus on March 13, 1901 (7 months after beginning of disease) and also with bacillus pyocyaneus. It was absent for both bacteria. It may be stated that the particular strain of pyocyaneus isolated from this case had been allowed to die out, and was not, therefore, used in determining the blood reaction. Dilutions of 1:25 were employed.

TYPHOID FEVER.

ROUTINE BLOOD EXAMINATIONS FOR "WIDAL" REACTION.

During 1899-1900 the quantitative method originated in this laboratory by Dr. L. B. Wilson and described* October, 1897, has been employed. These later experiences have not served to show either desirability or necessity for modification of the technique employed, since the method seems to combine the maximum of accuracy with a minimum expenditure of time and trouble. The detailed tabulation and publication of the results of the last 3,000 examinations has been planned, and will be prepared at the very earliest opportunity, together with a more complete description of all the steps employed, both in technique and in the collection and filing of data. The method, both as originally described and with some modifications, is employed by other laboratories with satisfactory results.

The following is a summary of examinations made for the period:

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*Wesbrook and Wilson. "The Serum Diagnosis of Typhoid Fever from the Laboratory Point of View." Transactions of American Public Health Association, 1897, and Philadelphia Medical Journal, March 26, 1898; Biennial Report, Minnesota State Board of Health, 1897-1898, pp. 193, 298, 303 (see also index, p. XIV).

TABLE NO. 8.

Examinations of blood of suspected typhoid patients for "Widal" reaction, 1899-1900.

January,	1899.	41	specimens	were	examined	from	7	localities.
February,	"	34	"	"	"	"	5	"
March,	"	60	"	"	"	"	6	"
April,	"	68	"	"	"	"	5	"
May,	"	44	"	"	"	"	3	"
June,	"	33	"	"	"	"	4	"
July,	"	53	"	"	"	"	12	"
August,	"	97	"	"	"	"	3	"
September,	"	29	"	"	"	"	8	"
October,	"	50	"	"	"	"	13	"
November,	"	36	"	"	"	"	6	"
December,	"	59	"	"	"	"	5	"
January,	1900.	56	"	"	"	"	10	"
February,	"	36	"	"	"	"	5	"
March,	"	71	"	"	"	"	6	"
April,	"	36	"	"	"	"	7	"
May,	"	21	"	"	"	"	6	"
June,	"	21	"	"	"	"	4	"
July,	"	39	"	"	"	"	10	"
August,	"	81	"	"	"	"	17	"
September,	"	58	"	"	"	"	14	"
October,	"	97	"	"	"	"	15	"
November,	"	53	"	"	"	"	10	"
December,	"	56	"	"	"	"	10	"

Total number of specimens examined, 1,229.

These examinations are frequently of considerable value to physicians as an aid to diagnosis, and a gradually increasing demand for them throughout the state is evidenced. When steps are taken to include typhoid fever under diseases reportable to boards of health, the examinations will be of still greater value.

METHOD OF REPORTING AND FILING RESULTS OF EXAMINATION OF BLOOD FOR "WIDAL" REACTION.

The need of some few words of explanation relative to the interpretation of the reports of results of examination was apparent, and in September, 1900, the report blank was modified and a method of filing similar to that for diphtheria was devised (see p. 507, this report). By this means all data, reports of all examinations and correspondence dealing exclusively with any case are

all filed in one envelope bearing on its face an abstract of the contents. These envelopes are filed alphabetically under patient's name; these are grouped under the name of the physician in attendance, and these names again under the locality of residence. The use of this filing system will greatly facilitate the work in future.

The following is a reproduction of the face of the report blank:

MINNESOTA STATE BOARD OF HEALTH, BACTERIOLOGICAL LABORATORY,
(UNIVERSITY OF MINNESOTA), MINNEAPOLIS.

REPORT OF SERUM TEST FOR TYPHOID INFECTION.

Examination No.................................. Received..........................

Patient's Name.................................... Address......... .. ..

Physician's Name.................................. Address.........................

Health Officer's Name .... Address.........................

Reaction ....

Remarks..

....

(OVER)

Reported...

Director. Assistant Bacteriologist.

Copy of telegram to

Upon the reverse side of the report blank the following is printed:

Reaction Present 1:25 means that the solution obtained by mixing one part of blood with 25 parts of distilled water has the property of clumping and arresting the motility of typhoid bacilli, added to it from a fresh culture. This indicates:

(a) The patient is now or recently has been infected with *B. typhosus.* In over 90% of cases the patient has enteric or typhoid fever. Reactions may, however, be due to some obscure infection with *B. typhosus*, e. g. osteomyelitis, abscess, meningitis, pneumonia, pleurisy, etc.

(b) Reactions infrequently persist from an old typhoid infection.

Reaction Partial or Questionable, may indicate:

(a) Typhoid infection too recent to afford typical reaction, which usually appears in 2 to 8 days after onset of symptoms.

(b) Error in collecting blood, usually presence of extraneous materials. Insufficient blood and the use of other material than the foil for collection of specimen may render accurate dilution impossible, and the report may read "not weighed." Too great concentration gives pseudo-reaction.

Blood must be dry when sent, otherwise opportunity for infection with other germs is afforded and satisfactory report may be impossible.

Whether beginning or pseudo-reaction may be determined by later examination.

REACTION ABSENT may indicate:

(a) Absence of typhoid infection.

(b) That it is too early in the disease for the appearance of the reaction. Rarely the reaction is delayed beyond the second week.

REMARKS:

In all cases, whether the reaction is present or not, physicians are urged to send other specimens at frequent intervals, and to fill out and return the blank sent from the laboratory with the first report on a case. All cases of typhoid infection should be regarded as dangerous to public health. Physicians are urged to take every precaution in the instruction of attendants, etc. Circulars of information dealing with the matter will be furnished on application to Dr. H. M. Bracken, Secretary of the Minnesota State Board of Health, St. Paul, Minnesota.

CLINICAL DATA.

It has been found very difficult to obtain clinical data, in spite of the fact that with the first report on each case is forwarded to the physician a special blank for clinical observation (see p. 195, Biennial Report of this Board, 1895-1898). This oversight on the part of physicians very much decreases the value and increases the labor of the tabulation of the records.

REPORT TO WAR OFFICE ON TYPHOID EPIDEMIC IN FIFTEENTH MINN. U. S. V., 1898.

At the request of Surgeon Major Walter Reed, U. S. A., president of the board of medical officers, specially appointed to investigate the occurrence of typhoid fever in the army during 1898, data of the observations made by the laboratory was forwarded after the permission of the State Board of Health had been granted at its quarterly meeting held Jan. 11, 1898.

The data consisted of portions of the reports from the laboratory for the quarters ending Sept. 30 and Dec. 31, 1898, (see p. 177 and 473, also Index, p. XIV., Biennial Report Minn. State Board of Health, 1897-98), and that embodied in the following letter:

Minneapolis, Minn., Jan. 21, 1899.

Dr. Walter Reed, Major and Surgeon U. S. A., President of the Board of Medical Officers, Washington, D. C.

Dear Sir: At the last quarterly meeting of the Minnesota State Board of Health, held a few days ago, I secured permission to forward you those portions of the quarterly reports of the laboratory for the quarters ending Sept. 30 and Dec. 31, 1898, in which the epidemic of typhoid fever in the Fifteenth Minnesota U. S. V. was dealt with. They are herewith enclosed.

From the report sent you by Dr. Bracken recently, of which I have a copy before me, it is evident that he has furnished you with rough maps and plans.

In making a systematic search for the possible original source of infection and the means of continued distribution of the *contagium* to which the daily occurrence of new cases for a considerable period apparently pointed, the laboratory had asked immediately for a plan of the arrangement of the tents, indicating the position of the infected soldiers and the date of the appearance of the illness. Owing to the great amount of work thrown suddenly upon the army medical officers, this was not furnished until the active work of the laboratory had ceased, and its value as an index of the advisability of making systematic bacteriological examinations for typhoid bacilli in the materials and places thus possibly brought to light, had been lost. In fact, had this been furnished then it would have been found very difficult to obtain data and materials after the patients had gone to the various hospitals (in St. Paul and Minneapolis) and out of the direct control of the army medical officers.

In order to facilitate matters in this respect, and to save time and trouble to Surgeon Major Dennis, ten copies of a letter written to him, and giving in detail the points upon which data was required, were forwarded, with the request that he accompany them by a personal note of request or command. He followed the suggestion, but largely without any resulting improvement.

If you have not a satisfactory map of the fair grounds, where "Camp Ramsey" was situated, I think that a request to the secretary of the Agricultural Society might secure it, though we have not succeeded in getting one. It is, however, probably an oversight, since the society, through its officers, met the advice and suggestion of this board in every way possible, and is deserving of great praise for its efforts (which were apparently quite successful) in rendering a visit to the annual state fair devoid of danger.

SOURCE OF INFECTION.

(a) The original source can only be guessed at. The close proximity and ease of access to Minneapolis, in which city something over 3,000 cases of typhoid fever were estimated in 1897, and something less in 1898, may explain the first cases. After the original infection, there were so many possible means of distribution permitted before the disease was diagnosed, and which were impossible of complete correction in a camp of raw recruits, that it is not strange that the infection became so widespread.

GENERAL WATER SUPPLY.

This is referred to and described in the first report from the laboratory. The unequal distribution, i. e., being nearly entirely confined for a long

time to four companies; the fact that no cases of the disease had occurred either in the Thirteenth Regiment stationed there before, or amongst the employes of the Agricultural Society resident on the ground; that the nature and slope of the surface of ground and underlying soil and the mechanism of pump, tank and pipes were such as to render infection improbable from such cases, had they occurred and been unrecognized; and that the infection continued or increased after the sterilization of the water containers and the discontinuance of this supply, all seemed to exclude the water as a source of original and subsequent infection.

The finding of a bacillus almost, if not identical, with *B. typhosus*, by Dr. A. W. Miller, bacteriologist to the St. Paul Board of Health, in the water as it flowed from a dilapidated rubber hose attached to the barrel-shaped delivery wagon tank used for ditributing water to the different company mess tents, cannot, however, be entirely overlooked. This micro-organism may have been picked up by the hose, which sometimes trailed on the ground, or may have been derived from the hands of attendants.

The micro-organism was sent to the laboratory for corroboration by Dr. Miller with three other pure cultures of *B. typhosus* isolated from the spleen, gall bladder and mesenteric glands of one of the fatal cases. The microbe in question had been obtained by the addition of the collected water to broth, incubation for some hours and injection into the peritoneal cavity of a white rat, which it killed in less than 24 hours. From the peritoneal exudate of the rat it was isolated in pure culture without difficulty by Dr. Miller, who gave the foregoing account.

The method of procedure involved was one which has never been employed in this laboratory, but the culture was examined and compared through all the culture media with five known typhoid cultures, three others then unknown and five known cultures of *B. coli communis*. It proved in the earlier experiments to be quite similar to the other cultures of *B. typhi abdominalis*, except that the growth upon pieces of the same potato was more abundant and of a yellowish brown color, and that at the end of 48 hours indol was to be clearly detected in cultures in Dunham's solution. This latter property has since disappeared. It is of the same size and degree of motility and reacts to known typhoid blood in parallel tests with cultures of *B. typhi abdominalis* and is of a corresponding degree of virulence for animals. Whether it was present in the general water supply and the significance of its discovery in the material from which it came, in the light of the method employed, are matters upon which this laboratory cannot give any opinion.

The examinations made by this laboratory, and all other examinations made by Dr. Miller of water from the various taps, pipes, mess tent, barrels, etc., which resulted negatively, are, of course, of little value.

ICE.

This was examined by Dr. Miller with negative results, but its use was discontinued in drinks immediately after the appearance of the first cases, though it was kept in closed barrels for the preservation of foods. It cannot, therefore, have been responsible for the later cases. The history of its source, which showed it to be generally used in St. Paul (where no typhoid fever has occurred), would seem to indicate that it was not the original cause of the epidemic.

MILK.

Milk was never supplied to the soldiers until after they had become infected, that is, until they required it for nourishment during the course of the disease.

FOOD.

A complete diet list was never received, though earnestly asked for, but in the opinion of this laboratory certain of the company mess tents appeared to be the places from which infection very largely spread immediately after the initial infection. This opinion was based upon the topographical distribution of the cases, that is, in four company rows.

It is not contended that this was the only factor, even at this stage, and certainly not after attention had been called to it. In relation to food, water and personal infection, must be considered the company privy sinks.

SINKS.

The original positions of the privy and kitchen sinks relative to the company mess tents was one worthy of some attention. One of the kitchen sinks was between the west end of the long line of company mess tents and the privy sinks, considerably closer, however, to the former. A glance at the plan of the original camp site, if you have one, will show these relative distances.

Inspection of the privy sinks, even after the placing of a guard there to compel the covering of *all* faeces and urine with lime immediately after their excretion, showed large uncovered masses of faeces, newspapers, etc., and fouling of the rails after the occasional washings with a disinfectant which had been suggested.* The use of these sinks by incipient and ambulatory cases would afford ample opportunity for direct personal and indirect food infection.

Flies, too, swarmed here, and it needed no very strong gale of wind, though one had occurred in the right direction, to carry them from here to kitchen sinks and company mess tents.

In one of the company mess tents (H), the cooked and other food was kept on ice in a barrel, carefully covered with a gunny sack, which, upon being lifted, revealed large numbers of flies which had gained access through cracks. Whether this was true of the food barrels in the other infected companies or not is unknown.

CULTURES FROM FLIES.

On August 23d flies were caught in sterile (autoclaved) metal cages (carried from and to the laboratory in sterile paper), from the privy sink (suspension of fly trap by a string for 10 minutes), and from Company "H" mess tent (by setting upon a cloth used for covering meat). The flies were induced to escape from the traps through inverted sterilized glass funnels into sterile

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*Even after removal from Camp Ramsey to the Fort Snelling reservation, and after suggestions before and then given by this board, and the strongest requests of Surgeon Major Dennis and the other army medical officers, the privy sinks were not properly disinfected.

flasks, where they were drowned by pouring sterile broth upon them. These cultures were incubated 24 hours, and plates then made. From the flies caught at Company "H" mess tent a bacillus was isolated from two colonies which had the character of *B. typhi abdominalis*, except that (a) growth is usually more abundant in the same length of time on agar and potato, (b) the virulence for animals has not been definitely established, (c) it does not react to known typhoid blood.

Attempts are now in progress to establish or increase its virulence, and to see if it is not possible to make it react to typhoid blood on the assumption of the possibility that it is *B. typhi abdominalis*, somewhat changed in character by its residence in or on the bodies of the flies.

All other cultures resulted negatively, and in view of the great number of possibilities offered for infection and the large amount of work necessitated in examining the blood of patients, the further examination of earth, foods, water, faeces, urine, etc., was not undertaken, though it might have converted possibilities to probabilities.

*BLOOD EXAMINATIONS.

Accounts of this work are given in the quarterly reports. It is necessary to state here that the method used was that originated by Dr. Wilson and used in this laboratory since October, 1897.

It is a matter of regret that concurrent bacteriological examinations of excreta could not have been done in all cases.

In summing up, the only positive result obtained is that, regarding the blood reaction as corroborative of clinical diagnosis, a widespread epidemic of typhoid fever has occurred.

There is no *absolute* proof of when, why nor where it originated, nor of how it was distributed from the first case or cases. There are, however, innumerable possibilities, of which some may be regarded as strong probabilities. Amongst them the following might be mentioned:

1. Infection of one or more cases either before or after mustering in.
2. Infection of privy sinks or general grounds from cases mentioned in paragraph 1 (discipline being necessarily lax at first, and there being no apparent reason for particular care).
3. Infection of food or water in the mess tents of Companies "H," "K," "N" and "F" from cases and materials mentioned in paragraphs 1 and 2.
4. Direct infection of cases more general in distribution from the rails, flies, etc., of privy sinks.

* * * * * * *

Anything that especially interests you and upon which you desire more information I shall be glad to place at your disposal, if it is available. I am,

Yours very truly,

F. F. WESBROOK,
Director.

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*For a summary of the blood examinations of 342 cases of typhoid fever, see p. 472, et seq., Biennial Report of this Board, 1897-98.

EXAMINATION OF WATER AND ICE SUPPOSED TO BE THE CAUSE OF TYPHOID FEVER AND GENERAL WORK IN BACTERIOLOGY OF WATER.

So far as time has permitted, studies have been carried on with a view to simplification of older methods and testing of certain newer ones in the hope that they might be made applicable in field work when the financial condition of the board warranted a conjoint chemical and bacteriological survey of the general natural water supplies for certain sections of the state, such as that of the Mississippi river, from near its source to its point of exit from the state. The work of the committee of the American Public Health Association on "Standard Methods of Water Analysis" has been followed with much interest, and the laboratory has collaborated as far as possible with this committee.

The general public still believes firmly in the ability to demonstrate or exclude with ease the presence of *B. typhosus* in any water suspected of causing typhoid fever. It fails to recognize the danger of giving decided opinions on specimens collected by persons unskilled in bacteriological technique and unaccompanied by data, nor does it see the necessity for repeated careful investigation of a water supply before passing judgment.

It has therefore been the aim of the laboratory to correct misconceptions, and only where the local authorities furnished some evidence of a possible or probable relationship of the water supply to existing disease have investigations been undertaken.

Where the occasion has seemed to demand it, one of the laboratory staff has gone out to make personal investigation.

In this way it has been found possible to avoid fostering misconceptions, and the creation of a demand for work of neither practical nor scientific value and the report upon which, no matter how carefully guarded, might give a false sense of security.

The following examinations made during 1899-1900 may be briefly mentioned:

1. *Benson, Minn.* During September, 1899, the occurrence of several cases of typhoid fever, led Dr. C. L. Schofield, H. O., to suspect the public water supply. Dr. Wilson visited the town, investigated conditions and collected data and specimens of water. Sterilized "Pasteur" filters were employed for the concentration of the bacterial contents of the waters.

Though the town is mainly supplied from surface wells, none of those examined showed evidence of fæcal contamination, *B. subtilis* being the only organism obtained. Proximity, however,

to probable sources of infection in the filthy premises surrounding the principal focus of infection was strongly suggestive that either the contamination had disappeared from the water or that the water alone had not been responsible for the disease.

The evidence of pollution afforded by a synchronous chemical examination served to strengthen the assumption that such a water supply (surface wells), even when showing no evidence of bacterial contamination (quantitative and qualitative) was unsafe, especially in consideration of the close proximity of sources of filth observed.

2. *Hopkins, Minn.* At the request of Dr. G. W. Moore, H. O., samples of the ice cut from a lake into which much organic material (animal and vegetable) was thrown, were examined on June 9, 1900. Contamination was not demonstrated, though Dr. Moore rightly condemned the ice on account of its source.

3. *Franklin, Minn.* *B. coli communis* was demonstrated in the water of a well, supposed by Dr. H. B. Cole, H. O., to be responsible for some cases of typhoid fever, and the water was condemned on Dec. 10, 1900.

4. *State Public School for Dependent and Neglected Children, Owatonna, Minn.* The occurrence of eight cases of typhoid fever in the school during the latter part of October and the beginning of November, 1900, led to a request on the part of the authorities for investigation of the water supply. Upon inquiry it was found that two or three weeks prior to the appearance of the first cases the supply tank for the storage and distribution of water to the institution had been emptied and cleaned, and during this day water from cisterns had been pumped directly into the delivery pipes. Dr. McDaniel visited the institution, collected data, took specimens and made cultures, plates, etc., from—

(a) The pipes through which the water from the driven well (132 feet deep) was pumped into the distributing tank.

(b) The distributing tank in tower.

(c Two cisterns for soft water and into one of which (B) surface water entered through defects in the walls.

The bacterial contents of the waters from the well and tank were concentrated by filtration for several hours through sterilized "Pasteur" filters and collection of the bacteria upon the surface of the cores. This was not found practicable for the cisterns, and may account for the discrepancies in the results.

The results of the bacteriological examination may be summarized as follows:

(a) Well water—Quantitative: 11 colonies per c. c.

Qualitative: No gas-producing organisms were found even in the "filter concentrated" material which was sown into carbolized, glucose broth in fermentation tubes. The predominating microbe was a bacillus which resembled *B. typhosus.* Its motility was doubtful, it did not "react" to known typhoid blood, and its growth on the various media was less abundant than parallel cultures of *B. typhosus.* It was pathogenic for guinea pigs. (Intraperitoneal inoculation.)

Chemical examination was not conclusive.

(b) Tank water—Quantitative: 26 colonies per c. c.

Qualitative: *B. pyocyaneus* and *B. coli communis* were isolated from concentrated material on the surface of a sterilized "Pasteur" filter by growth in carbolized, glucose broth in fermentation tubes. Chemical examination showed excess of free ammonia.

(c) Cistern A.—Quantitative: 48 colonies per c. c.

Qualitative: Nothing resembling *B. typhosus* or *B. coli communis* was obtained, though this cistern was subject to contamination by surface drainage.

Cistern B.—Quantitative: 1,185 colonies per c. c.

Qualitative: Only saprophytic bacteria and cocci. Chemical examination showed the water in the cistern to be worse than that in the tank.

The situation and construction of the well would seem to render contamination improbable, and the water contained only 11 bacteria per c. c. The significance of the typhoid-like bacillus is unknown; it is still under investigation. No new cases of typhoid fever have developed since the samples were collected, and it would seem that the organism found was therefore not *B. typhosus,* or was much attenuated. The tank showed marked bacteriological contamination *(B. coli communis* and *B. pyocyaneus)* and pollution was evidenced in the chemical examination. It is probable that it had been infected by the cistern water after cleansing, as the cistern water showed more chemical evidence of pollution and showed a higher bacterial count per c. c. Failure to find known pathogenic or gas-producing bacteria in the cistern water may have been due to the fact that "filter concentration" was not done, or such bacteria may have been present earlier, but had disappeared before examination. The bulk of evidence would go to show that the cistern water was responsible for the epidemic. Bacteriological and chemical examinations of the well and

tank waters at frequent intervals are necessary before making a final report.

SUNDRY EXAMINATIONS (B. TYPHOSUS AND B. COLI COMMUNIS).

1. Post-typhoid abscess in gluteal region. Negative results.

2. Fatal acute febrile jaundice (bacillus belonging to typhoid-colon group isolated).

On April 18, 1899, this laboratory began the examination of material removed *post mortem* by Drs. Wilson and Barber of Minneapolis from the body of a young woman who had died after 11 days' illness with symptoms of jaundice, high temperature, vomiting, hæmaturia, and abdominal tympanites. No gross lesions of the abdominal viscera were discovered at the limited autopsy held 21 hours after death and 19 hours after "embalming" by an undertaker. *B. coli communis* was found in large numbers in coverslip and culture preparations from the kidneys, spleen and liver. The only other organism present was a bacillus found in abundance in the spleen and liver, but not in the kidney. This bacillus is of the size and shape of *B. typhosus* and *B. coli communis*. Like them it is freely motile and produces a diffuse growth in broth and a slightly elevated whitish growth on serum and agar. It is like *B. typhosus* and unlike *B. coli communis* in giving no growth in Elsner's gelatine, in giving a faint white growth on potato, in producing no gas bubbles in glucose gelatine, and in producing only a trace of indol in Dunham's solution. On the other hand, it resembles *B. coli communis* and differs from *B. typhosus* in slowly coagulating milk and in acidifying litmus-lactose, litmus-saccharose, and litmus-glucose-agar, and Capaldi-Proskauer's medium.

It would appear therefore that the organism belongs in the typhoid-colon or Gærtner groups, but further study will be required to determine its place definitely.

It may be noted incidentally that in this instance two species of bacteria were alive and flourishing in the solid organs of the abdomen 19 hours after its injection with embalming fluid presumably in the usual manner and amount.

3. Chronic pyelitis and cystitis in female. *B. coli communis* found on two occasions in pure culture.

4. Cultures, some of them typical, either of the typhoid or colon group, and some whose exact classification is at present undetermined, have been isolated in the laboratory, and it is hoped

that they may be worked out in parallel series with a view of obtaining light upon the possible variation of *B. coli communis* and *B. typhi abdominalis* and their relationship.

(a) *B. typhosus* from Minneapolis water supply, 1897.

(b) *B. typhosus* from meningeal exudate of a fatal case of post-typhoid cerebro spinal meningitis, 1898.

(c) *B. typhosus* from the gall bladder—cholecystitis, 1900.

(d) Typhoid-like bacilli from flies at Camp Ramsey, typhoid epidemic, 15th Minn. U. S. V., 1898. These cultures at first differed only from *B. typhosus* in being non-pathogenic and not reacting to known typhoid blood. They have been made virulent in pure cultures for guinea pigs by passing through guinea pigs when mixed with staphylococcus pyogenes aureus and later reisolated.

(e, f and g) Three cultures from the same case—gall bladder and stones which present minor cultural differences and are neither typical *B. coli communis* nor *B. typhosus*, 1900.

(h) Unclassed bacillus from superficial chronic suppurative skin disease, 1900.

(i and j) Cultures from two cases of dysentery, in one of which amœba coli was found, 1900.

(k) Culture from well water at Owatonna, 1900.

(l) Culture from fatal case of acute febrile jaundice, 1900.

DIPHTHERIA.

The work in diphtheria accomplished by the laboratory from Jan. 1, 1899, to Dec. 31, 1900, has been of three classes.

A. *Routine Examinations*—Where specimens have been forwarded by the local health officer or attending physician from cases in which diphtheria has been suspected on clinical grounds reports have been made and records kept. These have been called for convenience "routine examinations."

B. *Special Investigations* have been made in certain localities. The local conditions have been studied and specimens collected by a representative of the state board of health.

These special investigations were undertaken to determine—

(a) The method of infection in certain epidemics in which the cause seemed obscure.

(*b*) The morphological types of diphtheria and diphtheria-like bacilli.

(*c*) The distribution of diphtheria and diphtheria-like bacilli in the throats and noses of the apparently healthy who were not known to have been exposed to diphtheria infection, as well as those who were known to have been brought in contact with clinical cases.

(d) What is a reasonable and correct basis for the imposition and release of quarantine in diphtheria?

C. *Laboratory Research*—During the course of the routine examinations and special investigations many interesting problems have presented themselves, and much material has been obtained for further study in the laboratory. Some idea of what has been acomplished in this branch of the work may be obtained by a perusal of the papers which have already been published elsewhere and are reprinted in this report (pages 582 et seq.)

New problems and increased material are continually brought to light, but this portion of the work, though increasing all the time, cannot be tabulated nor expressed in the same terms as routine examination of specimens from the suspected diphtheria patients or examination of groups of well people, such as constitute the routine and special examinations. It is therefore not included in the following table, which is intended to give the names of the localities from which specimens have been received, the number of examinations made, and the month and year in which the examinations were made. The table includes both *routine examinations* and the examinations made during *special investigations*, i. e., classes A and B.

Table No. 9 Showing Routine Examinations of Specimens from the Throats of Persons Who Were Supposed to Have Diphtheria, and Examinations Made During Special Investigations. January 1, 1899, to December 31, 1900.

Locality.	1899.												1900.												
	January.	February.	March.	April.	May.	June.	July.	August.	Septemb'r.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	Septemb'r.	October.	November.	December.	Total.
Abercrombie, N. D.															1		2		1						4
Ada										1															1
Adrian							1																		1
Albert Lea	8		6	1									1	6	2	4	1	1	2				2	1	35
Alden														2								4	1		7
Alexandria														1											1
Anoka											2	14	9	3				1							29
Arendahl	1																								1
Argyle																			6						6
Arlington																						1			1
Austin				1	5	2				2	6	6	2	1			4							2	31
Bagley																						16	10		26
Belle Plaine			2		1	3																			6
Barnesville																						1	5		6
Belgrade					1																			3	4
Bellingham																						1		1	2
Bemidji																		9			2				11
Beardsley																							4	1	5
Bena																			2						2
Biwabik												1			3		2	1		1					8
Blooming Prairie													4			1		2	1						8
Blue Earth City										5	4	3	3	3				1	1	8		26	4	2	60
Brainerd						1	6	6	3			1	2				3						1		23
Brownsdale													1												1
Brownton																						1			1
Browns Valley							1																		1
Buffalo																						1			1
Buffalo Lake											2	1							3						6
Butterfield		4					1		1			1		1				1							9
Caledonia																				14	9	29	49	13	114
Cambridge																								3	3
Canby																					5	4			9
Cannon Falls	10								2	1		1													14
Canton															1										1
Cass Lake																						1			1

Casselton, N. D.																		1						1
Chokio		1	5																		1			7
Clara City																				1	5	1	3	10
Clearwater		1																2	1	1			1	6
Cohasset																		2						2
Crookston								1		1		5	3							3				13
Dassel				2																	2			4
Deer River																		1						1
Delano					1																			1
Detroit City											4													4
Dexter									3	7	4		1			1								16
Dodge Center		1					1							2			2	1						7
Duluth			1														2	1		1		1	2	8
Dundee		1																						1
Eagle Bend				1																				1
Elbow Lake	2							1																3
Eden Valley																	1							1
Elgin						1						1	1											3
Elk River																					1	2	1	4
Elsworth												1												1
Enderlin, N. D.																						1		1
Eveleth							1						1					4	1	4	3	1	1	16
Excelsior												11										3	1	15
Fairfax																							2	2
Faribault									3	1	1			1		3	4	1		1	3	2	1	21
Fairmont																							4	4
Farmington	2	2	1																					5
Fertile			1						5	9		1			1	2				1	2	3	2	3	30
Finlayson																				1					1
Forestville																				1					1
Fosston								3									5			3		2			13
Ft. Snelling					2																			2
Frazee																1	1						2	16	20
Gibbon	2																							2
Glenville				6	9																		1		16
Graceville																2					2	8	8	7	27
Grand Rapids																	36	29	3			18	3		89
Granite Falls		1								1	1										1	6	13	12	35
Hallock										1	6	33	8						4	2	5				59
Hanley Falls																						1			1
Hanska																					3				3
Hastings									7	3	19	53	43	11	1	2	2					6	2	2	151
Heron Lake															2	1									3
Hayfield																			1						1
Hopkins																	3	16							19
Houston		1	1																			1	3	1	7
Jackson																		1							1
Jamestown, N. D.																						3	1	3	7
Janesville														1											1
Jordan		3	4																						7
Kensington																								1	1
Kenyon										2	8	2	8	2	2				6			3	2		35

Table No. 9 Showing Routine Examinations of Specimens from the Throats of Persons Who Were Supposed to Have Diphtheria, and Examinations Made During Special Investigations. January 1, 1899, to December 31, 1900.—*Continued.*

Locality.	1899.												1900.												
	January.	February.	March.	April.	May.	June.	July.	August.	Septemb'r.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	Septemb'r.	October.	November.	December.	Total.
Kimball																							4		4
Kindred, N. D																		1	1						2
Kilkenny																								4	4
Kingston																				2					2
La Crescent																	1	1							2
Lake City															1	1					2	2		1	7
Lake Elmo																			1						1
Lakefield														6	7	1						1			15
Lake Park		1	4	1										3	6										15
Lakeville															1						1		5	6	13
Lanesboro	1	1		1	1				1			1			1										7
Le Sueur Centre			4								1						1						2		8
Le Sueur					3			2	2	1			8	4	14	10	7	6				26	36	10	129
Little Falls			2																						2
Long Lake										1															1
Long Prairie					2	2									1	1				5	2	1	3	3	20
Luverne	1									1						6	10	5	7	1	3		11		45
Lyle					1																				1
Madelia												3				1						1		1	6
Madison																							4	1	5
Mankato									6	14	31	4	1	3				4		2	26	11	7	8	117
Marine Mills			3		2	4	1																	1	11
Milaca				1												5									6
Miller																			1						1
Minneapolis	6	8	8	10		5	2	1	8	3	18	25	13	5	10	9	7	1	8	5	20	27	32	41	272
Montevideo	3																								3
Montgomery												2										21	18	7	48
Monticello						3	1												2	1					7
Montrose													2							1					3
Moorhead																							5		5
Mora			11	4						5	15	3		5		1									44
Morgan	3	1																				2			6
Morris	5	4	2	1				1					2										1	1	17
Mountain Lake			5	1								2										3			11
New Brighton		3	5																						8

New Paynesville	1												1	3		12	6						3	1	27
North Branch														2	2										4
Northfield									2		1				1						3	5			12
One without data	1					1																			2
Osakis			1																						1
Owatonna			35	4	2	2	10								2	1								15	71
Park Rapids	16											4													20
Perham (and Silver Leaf)																								5	5
Pine City	11											2	2												15
Pipestone								1		1	8	2		1					2	5	1	15	32	7	75
Randall																						1			1
Red Wing														1											1
Redwood Falls										1				1		3									5
Renville																	2			1					3
Rochester																					9	11	2	1	23
Rockville																				1					1
Ronneby																						2			2
Rose Creek										1											3				4
Rosemount																	2	1							3
Rush City								1				46	53	9	13	26	16	18					4	7	193
Rushford	17	1	1	1		2	11	6																	39
St. Charles																								2	2
St. Cloud	1		3	4			7	3	3	18	10	11	4	1			2		1			6	7	2	83
St. Anthony Park											6	14		3			1								24
St. James							2	1			9	4	4	5	7	5		6	1	1					45
St. Martin																							2		2
St. Peter													1	1								2	1		5
Sacred Heart																1									1
Sandstone (and Hinckley)			2	4							2			1			1	1		1				6	18
Sauk Center					1		1									1									3
Scandia																								7	7
Shakopee					1	3																			4
Sherburne																				2					2
Springfield			1																						1
Spring Grove																							1	1	2
Stephen		2										1													3
Stillwater										4	2		1						2						9
Taylors Falls	3																								3
Torah	4	1	1	1		1						1				1									10
Tower														5	1	1					1			1	9
Tracy	1										2	2													5
Two Harbors																								8	8
Verndale			2	1																					3
Virginia		2		1						5	5	3	1	1		1						1		3	23
Wabasha								1			1			1											3
Wadena		1							3	8	2	1	5											2	22
Warren			11	1	1	1			1					2	1					1			1		20
Watkins																							2	4	6
Watertown															1										1
Waterville																							1		1
Waverly													1											1	2
Wayzata																				6					6

Table No. 9 Showing Routine Examinations of Specimens from the Throats of Persons Who Were Supposed to Have Diphtheria, and Examinations Made During Special Investigations. January 1, 1899, to December 31, 1900.—*Continued.*

Locality.	1899.												1900.												
	January.	February.	March.	April.	May.	June.	July.	August.	Septemb'r.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	Septemb'r.	October.	November.	December.	Total.
West Concord		2		1									1												4
White Bear								1																9	10
White Earth															2										2
Wheaton																					2				2
Willmar		1											1												2
Windom													1			3							1	1	6
Winnebago City									3	2	1	1													7
Winona				1	1					3													1		6
Wood Lake		2																							2
Worthington																							6		6
Wykoff																	3	4		1					8
Zumbrota									1	1															2
	99	45	122	49	34	31	46	29	54	103	171	267	189	97	84	107	127	117	63	74	113	290	314	249	......

Total routine examinations of diphtheria specimens for 1899 1,050
Total routine examinations of diphtheria specimens for 1900 1,824

Total routine examinations of diphtheria specimens for 1899 and 1900 2,874

SPECIAL INVESTIGATIONS.

Albert Lea, Jan. 13, 1899, cultures taken by Dr. H. M. Bracken .... 59 Examinations.
Elbow Lake, Jan. 24, 1899, cultures taken by Dr. H. M. Bracken .... 76 "
Faribault State School for Feeble Minded and City Public School, March 18, 1899, cultures taken by Dr. L. B. Wilson .... 223 "
Owatonna State Public School, examinations made by Dr. O. McDaniel from Jan. 1 to March 8, 1899 .... 3,486 "
Owatonna State Public School and City Schools, cultures taken by Dr. O. McDaniel on Oct. 6 and 7, 1899 .... 212 "
Mankato City Schools, Nov. 14, 1899, cultures taken by Dr. L. B. Wilson .... 61 "

Total examinations in special investigations, 1899 .... 4,117 Examinations.

Bethany Home, Minneapolis, April 9, 1900 .... 261 Examinations.
Bethany Home, Minneapolis, May 14, 1900 .... 236 "

Total examinations in special investigations for 1900 .... 497 Examinations.

Total examinations for presence of B. diphtheriæ, 1899 5,167
Total examinations for B. diphtheriæ for 1900 2,321

Total examinations for presence of B. diphtheriæ, 1899 and 1900 7,488

A study of the foregoing table shows—

I. Progressive Increase in Routine Examinations.

1. From Jan. 1, 1899, to Dec. 31, 1900, specimens were received from, examinations made for and reports sent to 186 different localities (181 in Minnesota and 5 in North Dakota). The position of the laboratory in Minneapolis may be considered as fairly central for most portions of this state, but Minnesota is large, and many of these specimens were sent from very great distances. This necessarily increased to some considerable degree the difficulties of operation.

2. During 1899 routine examinations were made for 92 different localities, and in 1900 for 151 different localities. The method of filing in the laboratory, which is explained later in this report, groups usually all the cases received from one physician together, so that where he has cases in different parts of the country, some of the points thus showing infection with diphtheria have not been here included. A grouping of the cases according to the locality and under the name of the local health officer would therefore show a greater number of localities from which specimens had been received. Such a grouping is not always practicable, since in some instances in order to be able to know exactly the condition of affairs in the cases under the charge of any one physician, where he is not the health officer, it is preferable to file them all under his name. Grouped alphabetically strictly according to place the data would be widely scattered.

3. The routine examinations for 1899 averaged 87 per month. For 1900 the average was 152 per month. The greatest monthly average is seen to be during the fall, winter and early spring months. The number of routine examinations, whilst not an absolute index of the amount of diphtheria infection in the state, corresponds fairly well for these two years. There was more widespread infection with diphtheria in 1900 than in 1899. (See the report of the secretary, this volume, page 31-46.)

II. Apparent Decrease in Special Investigations.

During 1899 4,117 examinations of specimens taken from the throats and noses of groups of children were made. These included 3,486 examinations made by Dr. McDaniel of this laboratory during the special investigation at the State Public School for Dependent and Neglected Children at Owatonna from January 1st to March 8th. The investigation was begun in November, 1898, and report made to Jan. 1, 1899. (See report of Minnesota state board of health for biennial period 1897-98, pages 461 to 472. Other

references under state public school, page XII, index.) This was a special investigation undertaken in collaboration with the management of the school. For further particulars see pages 515 et seq., of this report.

Owing to the widespread diphtheria infection met with in this school, it seemed advisable to undertake examinations of other public institutions, as well as groups of children, such as those in city, town and country public schools. In addition to the investigation made at the state public school, 631 examinations were made in 1899, whilst in 1900, 497 were made.

This apparent decrease is owing to the fact that during these investigations and in the course of routine examinations, materials for study accumulated very rapidly. This study of the various cultures, materials, records, etc., consumed a very great deal of time and energy, and could not be expressed in terms of "nose and throat examinations." In doing this special laboratory work, tabulation of records, etc., the diphtheria work in 1900 was really as great or greater than in 1899, though the other work of the laboratory, especially in diseases of animals, increased to an extent which somewhat interfered with the work on diphtheria as it had been planned.

III. Epidemics Occurred in Many Places in the State During This Period.

It must not be forgotten, however, that the number of examinations for any given place is not always a safe guide to the number of cases of diphtheria. Whilst local boards of health are supposed to be guided in the imposition of and the release from quarantine by laboratory findings, a comparison of the laboratory records with the reports to the Secretary of the State Board of Health by the local boards of health of the number of cases of diphtheria which occurred in their districts will show that specimens were not sent to the laboratory from many of the cases. (See pages 31 to 46 and 498 to 502, this report.) According to past and present regulations governing the quarantine of diphtheria, the minimum number of examinations should not be less than from 3 to 4 for each case of diphtheria. These examinations should be about as follows:

One positive report upon the receipt of which the local board of health imposes quarantine, usually later positive reports if the local authorities are anxious to secure an early release from quarantine and take pains to forward specimens for examination at fre-

quent intervals. Finally there should be two consecutive negative reports which formerly constituted the reason for the release of quarantine according to the regulations of the State Board of Health. This makes the minimum number of examinations not less than three for each case of diphtheria. An exception would occur in those rare cases where quarantine is imposed by the physician or local board of health on clinical grounds alone and where it is released on two consecutive negative laboratory reports. These cases are extremely rare and are of no value in making up the records of the work of the laboratory, because there is no bacteriological evidence that the disease was originally diphtheria. Such cases must be treated in the records as if they were not diphtheria.

Amongst the outbreaks of diphtheria in which the laboratory has made repeated examinations might be mentioned those at Albert Lea, Anoka, Austin, Blue Earth City, Brainerd, Caledonia, Fertile, Grand Rapids, Hallock, Hastings, Hopkins, Kenyon, Le Sueur, Luverne, Mankato, Montgomery, Mora, New Paynesville, Pipestone, Rush City, Rushford, St. Cloud, St. James and Wadena. In Minneapolis, for which a large number of examinations (272) is recorded for the two years, the work is done only as a matter of accomodation for certain physicians to whom the laboratory is more easily accessible than that of the local board of health. When a case is examined for a Minneapolis physician and *bacillus diphtheriae* is found the Commissioner of Health of Minneapolis is notified immediately and, as a rule, the state laboratory makes no more examinations, leaving the city laboratory to determine when quarantine shall be released. It is a matter of accommodation to physicians and collaboration with and courtesy to the local board of health.

Throughout the rest of the state have occurred a great many very interesting and instructive outbreaks, and did time and space permit it, the history of each would be well worth recording. In some of these places the schools were found widely infected and had to be closed for a time. In one of the localities mentioned matters were complicated by the breaking out of diphtheria in a hotel, whereupon all the inmates, incuding transients and regular guests, were confined to the building until one negative laboratory report showed each throat free from diphtheria bacilli. The patients themselves were isolated until two successive negative reports were made. In some of the localities in which outbreaks occurred the local boards of health and physicians became truly

alive to the condition of affairs early in the course of the disease and by taking proper steps prevented a wide distribution of infection. In those localities where the patients were isolated until all diphtheria bacilli had disappeared and proper disinfection was secured, little trouble was experienced. The methods used by the different boards of health and different physicians in the various localities infected were, however, far from uniform, and in certain instances the public evinced an interest in the management of affairs which stimulated the efforts of the authorities. It would seem that public sentiment is becoming such as to support even very stringent measures for the prevention of the spread of infection, and people are beginning to appreciate that what is a good regulation for their protection from infection from their neighbors is also good when applied to themselves for the protection of others.

The condition of things in the country districts is such as to make it very difficult, if not impossible, to comply with every detail of a regulation which makes a laboratory report responsible for the release as well as the imposition of quarantine. The danger of infection, however, in these cases separated by considerable distances from their neighbors, is less, and certain cases must therefore be dealt with on their own merits.

In special instances where some modification of the regulations seems imperative the matter, being strictly executive, is dealt with by the Secretary and Executive officer of the State Board of Health.

A. ROUTINE EXAMINATION OF SPECIMENS FROM CASES OF SUPPOSED DIPHTHERIA.

1. *Technique.** No marked changes in technique have been introduced during 1899-1900. The use of a rubber cap to cover the tube containing coagulated blood serum medium, which forms a part of the outfit for the collection and transmission of specimens, prevents drying and renders it unnecessary to exchange the outfit for a fresh one oftener than about every six months or longer. This more than compensates for the very occasional contamination of the tubes of medium which seems to occur in spite of every precaution in the putting on of the caps.

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*For technique, transmission of specimens, delays in reports on specimens, previous methods of reporting, filing of records, etc., see Circular of Information No. 2; Report Minn. State Board of Health, 1895 to 1898, pp. 34, 35 and 189 et seq., 447; also "Bacteriological Diagnosis of Diphtheria in Minnesota," this Report, p 594.

2. *Transmission of Specimens.** The formulation of regulations suitable to all concerned for the transmission of specimens through the mails has not yet been accomplished by the committee appointed by the American Public Health Association on transmission of diseased tissues by mail, though the matter has received much study and consideration in this laboratory.

The present regulations permit only of the sending of one tube in a case, and the laboratories employing it send a swab only to the physician, who rubs this over the suspected throat and returns it to the laboratory, where it is used for the inoculation of coagulated blood serum medium. In the experience of this laboratory this is not reliable because diphtheria bacilli, if present in the patient, may be found not to develop on the medium inoculated in the laboratory, though found to develop in similar medium inoculated at the bedside by the physician. This is the reason why a negative report is never made on a swab specimen.

3. *Reports* and filing of records of examinations.* Upon receipt of a specimen the box is opened immediately and the date and hour of receipt, together with the name of the express company by which it was delivered, are written upon the data slip which accompanies the specimen and which the physician has presumably filled in. The data slip receives a number which is the next in the series and is placed in the incubator with the specimen, which is examined after eighteen to twenty-four hours' incubation. Numbered reports in quadruplicate are made so that one is received by the attending physician, one by the local health office, one by the secretary of the State Board of Health and the original is filed in the laboratory with the data slip in a stout manila envelop numbered to correspond to the report and data slip. This bears on the outside the name of the physician and his address and is dated. A case card bearing the names and addresses of the patient, attending physician and health officer, and upon which is recorded each numbered examination with all other essential data, has been in use for the past two years. (See Biennial Reports, 1895 to 1898, p 447.) These cards contain then the essentials of all examinations made for any case and are filed alphabetically according to name of patient under the name of attending physician, also arranged alphabetically and grouped under the name of the locality, also in

*For technique, transmission of specimens, delays in reports on specimens, previous methods of reporting, filing of records, etc., see Circular of Information No. 2; Report Minn. State Board of Health, 1895 to 1898, pp. 34, 35 and 189 et seq., 447; also "Bacteriological Diagnosis of Diphtheria in Minnesota," this Report, p 594.

alphabetical arrangement. Whilst it is in this way that the records have been preserved for 1899-1900 and from such records that this report has been compiled, a better arrangement whereby the total data concerning any case might be conveniently filed so as to facilitate rapidly looking up all the facts in a case, or all the cases in a locality, has been contempated for some time. The formulation and adoption of the classification of types of diph theria bacilli (see p. 613 of this report) and desirability of several changes in methods suggested the following system, which will be employed on and after January 1, 1901.

The following is printed on blue paper so as to readily distinguish it from the typhoid "blood reaction" data slip, which is yellow. One of these slips is to be sent out with each diphtheria outfit:

MINNESOTA STATE BOARD OF HEALTH, BACTERIOLOGICAL LABORATORY,
(UNIVERSITY OF MINNESOTA), MINNEAPOLIS.

DATA TO ACCOMPANY SPECIMEN FOR DIPHTHERIA EXAMINATION.

Please fill out this blank in full and leave in box.

Date and hour ....

Patient's Name .... Address ....

Physician's Name .... Address ....

Health Officer's Name .... Address ....

Has this case been reported on before? .... If so, give last examination No. ....

Patient's Age .... Sex .... Temperature ....

How long since disease commenced? .... Is a membrane present? ....

Remarks ....

Physician's diagnosis .... Do you desire a telegraphic report? ....

Immediately upon examination the result will be recorded upon a report blank in quadruplicate by means of a hard indelible pencil and interleaved carbons and the reports numbered serially to correspond with the data blanks.

The following will be printed on one side of the report blank:

MINNESOTA STATE BOARD OF HEALTH, BACTERIOLOGICAL LABORATORY,
(UNIVERSITY OF MINNESOTA), MINNEAPOLIS.

REPORT OF EXAMINATION FOR DIPHTHERIA.

Examination No...Received..............................

Patient's Name... .Address.........................

Physician's Name..Address........................

Health Officer's Name ....Address.........................

Examination—Throat Culture...

....

Remarks ....

Diagnosis ....

(OVER)

Copy of telegram to

Reported..

Director. Assistant Bacteriologist.

The reverse side bears the following:

NOTE CAREFULLY:

The diagnoses given vary in wording and interpretation as follows:

I. "*Diphtheria*," means that *B. diphtheriæ* was demonstrated culturally and miscroscopically, with or without marked admixture with other microbes. When others are numerous their presence is noted. The relative number of the bacilli of diphtheria found, or their short or long persistence in the throat, cannot be taken as an index of the danger of contagion.

Certain letters in parenthesis following the words "*B. diphtheriæ*" indicate the morphological varieties of the bacilli present and are for laboratory reference only.

II. "*No diphtheria bacilli found*," means simply that *B. diphtheriæ* was not found in the specimen examined, which may have been due to:

(a) Improper technique in applying the swab to the throat. Considerable vigor should be used so that not only the prominent parts of the mucous membrane, but the depressions have been rubbed. The depressions are less apt to have been mechanically cleaned by swallowing foods, gargling, etc.

(b) Some antiseptic may have been used in the throat immediately prior to taking the specimen, thus interfering with subsequent development of the culture.

(c) Improper technique in smearing the swab over the surface of the medium, whereby the infected surface of the swab was not brought in contact with the solidified serum.

(d) It is, of course, possible that a very few diphtheria bacilli, amongst a large number of other bacteria, in the growth might be overlooked in the laboratory. This, after careful statistical study of many examinations, has been found to be unlikely to occur.

(e) Entire absence of *B. diphtheriæ* in the throat.

III. No diagnosis may be given on account of non-development or scanty growth of culture. This frequently happens when specimens are received on swabs or dried media. Then "*No Growth,*" "*Scant Growth,*" or "*Specimen Unsatisfactory,*" is reported and another specimen is asked for. A negative diagnosis is never made on a specimen sent in any other way than on fresh culture medium (Löffler's blood-serum).

All data blanks and reports of all examinations of any case, together with other data, such as correspondence dealing exclusively with the case, are to be filed in a stout manila envelope opening at the left-hand end and bearing the following printed in red to easily distinguish it from the typhoid "blood reaction" filing envelopes, which are printed in black:

Patient....................Dr...... ....address...................

Age....sex......address..............H. O..............address........ ....

Examination No.	Day of Disease.	Date of Culture.	Date of Diagnosis.	Diagnosis.	Remarks.

These are to be filed alphabetically according to name of patient under the name of the attending physician, alphabetically arranged, which is in turn to be filed under the name of the locality, also in its proper alphabetical order.

In cases where diphtheria bacilli are reported present the filing envelopes will be filed temporarily as above for reference until observations are completed. When observations have been completed in positive cases and in all negative cases the filing envelopes will be filed permanently for tabulation in the same way as above. When nothing further is heard from a case within two months after the last positive report it, too, will be filed permanently.

A daily record arranged in the order of the serial examination numbers makes it easily possible to look up quickly the number of

examinations in a given time; or by affording names and addresses of patient and physician and laboratory findings to refer to all information concerning a case in which only examination number or date is known.

TABLE NO. 10, SHOWING THE REPORTS MADE BY THE LABORATORY ON SPECIMENS RECEIVED FROM CASES OF SUSPECTED DIPHTHERIA, JAN. 1, 1899, TO DEC. 31, 1900. THESE "ROUTINE EXAMINATIONS" NUMBERED 1,050 DURING 1899 AND 1,824 DURING 1900, THE TOTAL FOR THE TWO YEARS BEING 2,874:

	1899.	1900.	Total for 2 Years.
Cases in which "No diphtheria bacilli found" was reported	258	487	745
Cases from which specimens were "unsatisfactory," no report could be made and they were not heard of again	57	96	153
Cases in which "B. diphtheriæ present" was reported	270	553	823
Total number of cases in which observations were completed during 1899-1900	585	1,136	1,721

The above table shows that in 745 out of a total of 1,721 cases a careful examination failed to show the presence of bacilli diphtheriae.

"No diphtheria bacilli found" is the wording of the reports made upon such specimens.

Where a physician still has reason for believing that the case is diphtheria he is supposed to forward a second specimen for examination and to communicate with the laboratory as requested in Circular of Information No. 2. This is not done very often, though on some occasions a primary negative report has been verified by a second, or even very rarely a third negative. On a few occasions a primary negative has been followed by a later positive, when enquiry has shown this to be due frequently to some mistake in the technique of collection or transmission.

A perusal of the notes relative to the interpretation of the wording of reports, which are printed on the reverse side of the report blank, should be more helpful to physicians than it seems to be.

The fact that so large a percentage of specimens is received from cases which turn out not to be diphtheria speaks well for the increasing carefulness of physicians as well as for the education of the public.

"Unsatisfactory specimens" result often from the fact that the physician has either not employed the regular outfit for the collection and transmission of the specimen, or has used an outfit in

which the medium has become dry or contaminated. Sometimes delay on the part of an express company, or delay on the part of the physician even in forwarding the specimens which may not be shipped for several days after collection, results in inability to give a satisfactory report. In all cases "Please send another specimen" is written on the report sent. Sometimes word comes from the physician that all symptoms have abated within a few hours after the specimen has been sent. From most of these cases, however, nothing further is heard.

One hundred and fifty-three "unsatisfactory specimens" in 1,721 cases is, however, altogether too large a proportion.

Should it be possible to hit upon some simple outfit small enough to be easily carried like a clinical thermometer, and which will not require to be renewed, but remain ready for use for a long time, these difficulties will be largely dissipated. Changes in the postal regulations so as to make it possible to utilize the mails and special delivery will also be helpful to this end.

"*B. diphtheriae present*" was reported in 823 cases out of a total of 1,721 people from whom specimens were received. To the secretary of the State Board of Health were reported from all sources 1,986 cases of diphtheria during 1900 (see this Report, p. 46), whilst from the laboratory only 553 cases were reported as positive. This means that only 27 per cent of the total number of cases of diphtheria officially known to the State Board of Health were examined by this laboratory, if all of the above 1986 cases were really diphtheria.

REGULATION OF QUARANTINE BY LABORATORY FINDINGS.

The last change of the regulations of the State Board of Health governing the quarantine of diphtheria (see this Report, pp. 31 and 32) was based upon suggestions made by the laboratory in the communication on "Bacteriological Diagnosis of Diphtheria in Minnesota" (see this Report, p. 594) on Jan. 9, 1900. These regulations call for negative laboratory reports on synchronous nose and throat culture for the release of diphtheria patients from quarantine. This has not yet been insisted upon, partly because of inability to contrive suitable outfits for taking and transmitting specimens.

It is, however, based on correct principles, as may be seen by consulting the reports of special investigations (this Report, p. 514 et seq.)

These tables therefore contain only the results of examinations of *throat* cultures, as quarantine has been supposed to be raised only after two successive negative reports have been made on cultures from the throats of diphtheria patients in accordance with the rule which obtained prior to the change mentioned above. In 1889, 207 cases and in 1900, 410 cases, or 617 in all, in which the last report made was positive, were not heard from again, and it is presumed that they were released from quarantine upon the disappearance of clinical symptoms, or after the lapse of a time which seemed to the local authorities sufficient for the disappearance of all danger of infection. This is altogether wrong, for if the physician admits his inability, as he must, to know at all times when B. diphtheriæ is present in the beginning of clinical symptoms, how is he to know any more correctly by clinical observation alone when it has disappeared and the patient is again free of the danger of communicating the disease to others?

"Duration of quarantine when regulated by laboratory findings." (See also p. 602, this Report.)

During 1899 and 1900, out of a total of 823 cases of diphtheria examined by the laboratory, 54 cases were examined and re-examined until two final consecutive negative reports upon throat specimens were made, and 154 were kept under observation until one negative report had been given.

An analysis of these cases is of interest.

TABLE NO. 11.

ANALYSIS OF DIPHTHERIA CASES DURING 1899 AND 1900 IN WHICH LABORATORY EXAMINATIONS WERE CONTINUED UNTIL B. DIPHTHERIÆ WAS PRONOUNCED ABSENT:

No. of Cases.		No. of days after first appearance of disease.
17	B. diphtheriæ had disappeared in less than.................	10
23	B. diphtheriæ had disappeared between.....................	10 and 14
23	B. diphtheriæ had disappeared between.....................	15 and 18
57	B. diphtheriæ had disappeared between.....................	19 and 22
48	B. diphtheriæ had disappeared between.....................	23 and 30
21	B. diphtheriæ had disappeared between.....................	31 and 40
6	B. diphtheriæ had disappeared between.....................	41 and 50
11	B. diphtheriæ had disappeared between.....................	51 and 60
2	B. diphtheriæ had disappeared between.....................	90 and 97
208		

According to the above table—

20 per cent of all patients were released in two weeks.

39 per cent of all patients were released in the next eight days.

23 per cent of all patients were released in the next eight days.

This means that 82 per cent were released before they had been ill thirty days, which is a much shorter time than a time limit of four weeks after the disappearance of the membrane (when present) and all symptoms. The remaining 18 per cent would have been a source of possible danger to the communities and were justly not allowed to mix with the public until the bacilli had disappeared. The inclusion of all cases, even the two in which the bacilli persisted for ninety and ninety-seven days respectively, gives an average of twenty-four days as the time of persistence of B. diphtheriæ in these cases. But this average time of twenty-four days must not be adopted as a time limit, because many of the cases showed B. diphtheriæ for a much greater time.

This average for the whole of 1899, 1900 is less than that for 1899 alone, which is twenty-nine days. (See p. 602, this Report.) Had specimens been sent at more frequent intervals it is to be presumed that the average length of the time of persistence of B. diphtheriæ would have been less than it is.

It should be borne in mind by physicians that B. diphtheriæ may be absent on the day following the report of its presence. In many of the cases examined specimens were not sent more frequently than every week or fortnight. The inconvenience to the physician and expense of the physician's visit to the patient may be partially responsible for this.

B. SPECIAL INVESTIGATIONS.

STATE PUBLIC SCHOOL FOR DEPENDENT AND NEGLECTED CHILDREN, OWATONNA, MINN.

In 1896 the State Board of Health was called to investigate the reasons for the frequent occurrence of cases of diphtheria and sore throats in this school. Some of the results of the investigation were presented in "A Preliminary Communication on Bacillus Diphtheriæ and its Variants in a School in Which Diphtheria Was Epidemic," which was read before the British Medical Association at Montreal, 1897, and appeared in the biennial report of the State Board of Health 1895-1898, page 321 et seq. Since 1896 the appearance of occasional sore throats, and more rarely, cases of clinical diphtheria, has led to the continuation of the studies then commenced. Attempt was made to guard against the occurrence of mild as well as severe diphtheria by housing the patients in a separate building until two negative reports sent by the laboratory

indicated that the throats were free of diphtheria bacilli. The children whose throats were infected with B. diphtheriæ, even when they had no clinical symptoms, were also confined in this way in the hope that all diphtheria and diphtheria-like forms would ultimately be eradicated. These proceedings were inefficacious, and on Nov. 22, 1898, Dr. O. McDaniel, assistant bacteriologist in this laboratory, was placed in charge of a branch laboratory established at Owatonna. One of the buildings was temporarily divided into fifty-three compartments. Previous examinations having shown that nearly 50 per cent of the children were infected with diphtheria or diphtheria-like bacilli, it was decided to place each child in one of these compartments and to treat his nose and throat until three consecutive examinations of each (six in all) showed absence of all diphtheria and diphtheria-like bacilli. The examinations and the superintendence of the work was in the hands of Dr. McDaniel. (For a fuller account of the details see Biennial Report, Minnesota State Board of Health, 1895-1898, pages 390, 391 and 461 et seq; also "Studies on the Distribution of Certain Varieties of the Diphtheria Bacillus," volume XV., Transactions of the American Public Health Association, and this Report, page 583; also "Varieties of B. Diphtheriæ," Transactions of the Association of American Physicians, 1900, and this Report, page 613; also "Bacteriological Diagnosis of Diptheria in Minnesota," St. Paul Medical Journal, April and May, 1900, and this Report, page 594.) In the last Biennial Report a full account of the work to Jan. 1, 1900, is given.

At the beginning of March, 1899, the attempt to cleanse all children of diphtheria and diphtheria-like bacilli ceased. From Nov. 29 to Dec. 31, 1898, 1,689 examinations were made by Dr. McDaniel, and from January 1st to March 8th, 3,486 examinations, making in all 5,175 examinations.

The conditions which led to the discontinuance of the work in Owatonna were as follows: A total of 193 children who had been passed through the "quarantine filter," i. e., had been placed each in a compartment until three consecutive examinations of both nose and throat showed absence of all diphtheria and diphtheria-like bacilli, were distributed in four cottages which had been specially cleaned and sterilized by the use of sulphur and formalin for their reception. A systematic examination of these children, supposed to be free of diphtheria and diphtheria-like bacilli, disclosed the fact that twenty-seven showed infection in either nose

or throat or both with B. diphtheriæ, that is, morphologically "typical"* forms, and fifty-two showed infection in either nose or throat or both with "atypical" forms.

The investigations of the conditions of the throats and noses of the town school children at Owatonna and Waseca (see State Board of Health Biennial Report 1895-1898, pages 390 and 391; also 468 et seq) and of Albert Lea and Elbow Lake (see this Report, page 523) having also shown some infection with "typical" and a wide-infection with "atypical" forms, the authorities at Owatonna felt that to continue longer in this work would be vain. Dr. McDaniel had examined also twenty-two of the children who had been received from various portions of the state for admission into the school and found diphtheria bacilli and diphtheria-like forms quite abundant. There was no demonstrable reason for the conditions in the school, since the children had enjoyed an immunity from all throat infections and their general health had never been better than during the investigation, that is, for several months.

The following possibilities have suggested themselves as having a possible relationship to the condition.

1. Though the four cottages had been sterilized and the children, so far as could be determined by successive examinations, were free of all diphtheria and diphtheria-like bacilli when they entered and were afterwards kept isolated, no systematic examination of the throats and noses of the attendants was made. It is possible that this may have been the channel of infection. One of the girls who was assisting in the care of the babies in "Cottage IV." had "typical" diphtheria bacilli present, and a culture taken at random from one of the employes showed also diphtheria bacilli.

2. The freedom of the children from bacillus diphtheriæ may have been only apparent. Had one in each cottage been infected

*Prior to this time no complete classification of the diphtheria and diphtheria-like bacilli had been made. The various forms met with were described as "typical" and "atypical." This method was so unsatisfactory and the records thus made so indefinite that a more accurate classification had to be formulated, and in October, 1899, a preliminary announcement was made of a classification which was completed in the early part of 1900. (See plates and descriptions "Varieties of B. Diphtheriæ," this Report, page 613.) This later provisional classification has been employed ever since in recording the results of routine examinations from clinical cases or examinations in special investigations. The "typical" bacilli of the old nomenclature were those whose presence in cultures from the throats of clinical cases of diphtheria would be sufficient grounds for quarantine. They include A, B, C and D in the new classification. Certain other of the types in the new classification when grouped in certain combinations would also be classified as "typical." The principal types of the new classification included under "atypical" forms of the old classification are D_2, E_2 and G_2. In all the tables of special investigations made during 1899-1900 the terms "typical" and "atypical" have the above meanings. In the tables of special investigations where the presence of "typical" forms in a nose or throat is shown it does not mean that "atypical" forms were not also present in the same culture, but where "atypical" forms are recorded it means that no admixture of "typical" forms was discoverable in that particular specimen.

the later wider infection may be readily explained, as in play, etc., opportunities for the exchange of throat and nose contents in children is easily seen. As bearing upon this point it may be mentioned that some of the children had been kept without treatment in the "filter" for various periods and did not show B. diphtheriæ or any suspicious forms for, in one case, so long a period as thirteen days.

3. The food and milk supply in the cottages is the same as that in the "filter," but in the "filter" each child has its own utensils. It may be mentioned that the man who had charge of the farm had, at the time of the conclusion of this investigation, a sore throat, which was not examined bacteriologically. The cows had been examined repeatedly by a veterinarian and the milk had been examined several times by this laboratory with negative results. The water supply has been examined also several times without, however, finding B. diphtheriæ present.

In view of the possibilities above mentioned the following provisional suggestions were made at the time:

"As no sterile cottage remains in which the experiment can be tried, it would seem advisable to keep in the 'filter' the children who are now there and who may be shown to be free of diphtheria and diphtheria-like bacilli. Allow them to live as nearly as possible under the same conditions as though they inhabited a cottage, i. e., mix together and live in one of the rooms from which the compartments have been removed. They will then be under the eye of Dr. McDaniel and of the nurse in charge. It is hoped that this will show whether it is possible to keep a number of children together in this school without infection with diphtheria and diphtheria-like bacilli. This is the time to make such a trial, since everything is arranged for its carrying out without trouble or expense. If the results show that the children cannot remain diphtheria-bacillus free it should be possible to show exactly how the infection occurred, and the knowledge thus gained may probably be utilized elsewhere in the school."

A meeting of the executive committee of the State Board of Health was held in the secretary's office in St. Paul on March 8, 1899. Mr. Merrill, superintendent, and Dr. Adair, physician to the State Public School, as well as Dr. McDaniel, were present at this meeting, and it was decided to stop further bacteriological work. Whilst the results of the work had not shown all that they had hoped for, the authorities at Owatonna expressed themselves as

glad that it had been done. They now enjoyed a feeling of rest from the unsettled conditions which had prevailed during the last three years, which they felt would not have come to them in any other way. The general health of the children was better at this time than it had been before.

The plan adopted for the future isolation and care of clinical cases of diphtheria, as expressed by the superintendent and Dr. Adair, was as follows:

"1. Hereafter all sore throats shall be quarantined until two negative reports have been made by the laboratory."

"2. All new and returned children shall be quarantined for two to three weeks."

It is interesting to note that of five cases of otitis media with discharge, diphtheria or diphtheria-like bacilli were found in all. One case of slight inflammation of the conjunctiva, with scarcely a perceptible exudate, also gave a growth of diphtheria bacilli. In the case of one girl (M. R.), age eight, who was received by the authorities Nov. 29. 1898, and for whom fifteen examinations were made, diphtheria bacilli were found the first six times and on the eighth time of examination. The seventh examination, and in all the examinations from the ninth to the fifteenth, the results were negative, whereupon she was discharged on Dec. 16, 1898, and sent to a home in the state for adoption. She returned to the school on Jan. 1, 1899, and showed "typical" forms of B. diphtheriæ in her throat. She was still present in the "filter" on March 8th at the cessation of the examinations. In all fifty-three examinations were made for this child, and diphtheria bacilli were found present to the last.

The following table shows the distribution of diphtheria and diphtheria-like bacilli in the throats and noses of children who had passed through the "filter" and who were supposed to be free of all diphtheria and diphtheria-like bacilli:

Table No. 12, Showing Distribution of Diphtheria and Diphtheria-like Bacilli ("Typical"* and "Atypical") in the Throats and Noses of the Inmates of the State Public School for Dependent and Neglected Children at Owatonna, Minn., within a Short Time after Each had been Shown to be Free of *all* Suspicious Forms by Three Successive Negative Examinations of Both Throat and Nose before Dismissal from the "Filter."

	Cottage I. (Boys.)	Cottage II. (Boys.)	Cottage III. (Girls.)	Cottage IV. (Baby Cottage.)	Girls Assisting in Cottage IV.	Total.
1. Number of persons showing *throat infected with "typical"* B. diphtheriæ (nose free of diphtheria-like bacteria)......	1	0	0	1	0	2
2. Number of persons showing *throat infected only with "atypical"* forms of B. diphtheriæ (nose free of all diphtheria-like bacteria)......	0	1	1	0	0	2
3. Number of persons showing *nose infected with "typical"* B. diphtheriæ (throat free of all diphtheria-like bacteria).........................	4	5	2	0	0	11
4. Number of persons showing *nose infected only with "atypical"* forms of B. diphtheriæ (throat free of all diphtheria-like bacteria).............	13	15	9	4	0	41
5. Number of persons showing *both throat and nose infected with "typical"* B. diphtheriæ.	2	1	0	0	1	4
6. Number of persons showing *both throat and nose infected only with "atypical"* forms of B. diphtheriæ..................	2	5	1	1	0	9
7. Number of persons showing *throat infected with "typical" B. diphtheriæ*, with "*atypical" forms only in the nose*.........	2	5	0	0	0	7
8. Number of persons showing *throat infected only with "atypical"* forms, with "*typical" B. diphtheriæ in the nose.*	2	1	0	0	0	3
9. Total number of persons showing *infection in either nose or throat, with "typical"* B. diphtheriæ (add 1, 3, 5, 7 and 8).	11	12	2	1	1	27
10. Total number of persons showing *infection in either nose or throat, with "atypical" forms*, all "typical" B. diphtheriæ being absent (add 2, 4 and 6)	15	21	11	5	0	52
11. Total number of persons showing *infection in either nose or throat with either "typical"* B. diphtheriæ or suspicious forms (add 9 and 10)..........	26	33	13	6	1	79
12. Total number of persons *uninfected with "typical" B. diphtheriæ, i. e.*, showing no "typical" B. diphtheriæ in either nose or throat................	50	51	40	23	2	166
13. Total number of persons *uninfected with even "atypical" forms* of B diphtheriæ, *i. e.*, all suspicious forms absent from both nose and throat....	35	30	29	18	2	114
14. Total number of people examined (add 9 and 12, or 11 and 13)......................	61	63	42	24	3	193
Percentage infected with B. diphtheriæ, *i. e.*, bacilli morphologically "typical"........	18	19	5—	4+	33+	14
Percentage doubtful, *i. e.*, infected with bacilli morphologically "atypical"..........	24+	33-	26+	21—	0	27
Percentage free of even suspicious forms....................	57+	47+	69-	75	67—	59

*See footnote, p. 516 this Report, for interpretation of terms "typical" and "atypical."

A study of the preceding table shows that the boys inhabiting Cottages I. and II. showed a greater percentage of infection with morphologically "typical" bacilli (18 and 19 per cent, respectively) than did the girls in Cottage III. or the babies in Cottage IV. in whom the percentage of infection was 5 and 4, respectively. The "atypical" forms found in the children who had no "typical" forms at all present averaged 27 per cent. Excluding the three girls who were assisting in the care of the babies in Cottage IV., the infection of the children in all four cottages with "atypical" forms only was fairly uniform, varying from 21 to 33 per cent. This is in marked contrast to the distribution of the "typical" forms, in which the variation was from 4 to 18 per cent; in other words, the percentage of infection with "typical" forms in the boys was much greater than it was in the girls and babies, whilst the percentage of the people infected only with "atypical" forms was nearly the same in all.

It is interesting to note that in the three cottages containing the boys and girls, there were eleven of the inmates who showed the nose infected with "typical" forms, whilst the throat was free of all diphtheria-like bacilli. Only one, a boy in Cottage I., showed the "typical" forms in the throat, the nose being free of diphtheria-like bacilli. The converse condition of affairs obtained in the baby cottage. In this investigation had specimens been taken only from the throat (add Nos. 1, 5 and 7 of table), thirteen would have shown the presence of "typical" B. diphtheriæ, whilst if specimens had been taken from the nose and not from the throat (add Nos. 3, 5 and 8 of table), eighteen would have shown the presence of the "typical" forms. Four of the children had the "typical" forms in both nose and throat, making in all the twenty-seven infected with "typical" forms.

During the summer following the cessation of the work at Owatonna, the children were remarkably free from sore throat, as well as all kinds of acute illness. This persisted throughout 1899-1900, and is worthy of mention because during this time there was a great deal of diphtheria in the state at large, and, in view of the fact that children are received at the school from all parts of the state, frequently from environments far from healthy, it is all the more striking. Some connection between the thorough cleansing and medication of their throats and noses, and this immunity from disease would seem to exist. The questions raised during the work at Owatonna led to the investigation of a number of other groups of children throughout the state as to the possibility of

their infection with diphtheria and diphtheria-like bacilli, and it seemed desirable to take again cultures from the school, and accordingly Dr. McDaniel visited Owatonna on Oct. 6 and 7, 1899, and together with Dr. Adair took cultures from the city public schools and from sixty-six children at the state public school.

The following table shows the results obtained in the hospital, receiving cottage and Cottage V. of the state public school.

Table No. 13, Showing Distribution of Diphtheria and Diphtheria-like Bacilli (*"Typical" and "Atypical") in the Throats and Noses of Certain Inmates of the State Public School for Dependent and Neglected Children at Owatonna, Minn., on Oct. 7, 1899, 8 Months after the Cessation of the Attempt to Eradicate Diphtheria-like Bacilli from Their Throats and Noses by Means of Isolation in the "Filter."

	Hospital.	Receiving Cottage.	Cottage V. (Boys)	Total.
1. No. of persons showing *throat infected with "typical"* B. diphtheriæ (nose free of all diphtheria-like bacteria)	2	0	1	3
2. No. of persons showing *throat infected only with "atypical"* forms of B. diphtheriæ (nose free of all diphtheria-like bacteria)	1	1	1	3
3. No. of persons showing *nose infected with "typical"* B. diphtheriæ (throat free of all diphtheria-like bacteria)	0	0	1	1
4. No. of persons showing *nose infected only with "atypical" forms of* B. diphtheriæ (throat free of all diphtheria-like bacteria)	1	6	3	10
5. No. of persons showing *both throat and nose infected with "typical"* B. diphtheriæ	0	0	4	4
6. No. of persons showing *both throat and nose infected only with "atypical"* forms of B. diphtheriæ	6	6	17	29
7. No. of persons showing *throat infected with "typical" B. diphtheriæ* with *"atypical" forms only in the nose*	0	2	4	6
8. No. of persons showing *throat infected only with "atypical"* forms with *"typical" B. diphtheriæ in the nose*	1	0	0	1
9. Total No. of persons showing *infection in either nose or throat with "typical"* B. diphtheriæ (add 1, 3, 5, 7 and 8)	3	2	10	15
10. Total No. of persons showing *infection in either nose or throat with "atypical" forms*, all "typical" B. diphtheriæ being absent (add 2, 4 and 6)	8	13	21	42
11. Total No. of persons showing *infection in either nose or throat with either "typical" B. diphtheriæ or suspicious forms* (add 9 and 10)	11	15	31	57
12. Total No. of persons *uninfected with "typical" B. diphtheriæ*, *i. e.* showing no "typical" B. diphtheriæ in either nose or throat	10	16	25	51
13. Total No. of persons *uninfected with even "atypical" forms* of B. diphtheriæ, *i. e.* all suspicious forms absent from both nose and throat	2	3	4	9
14. Total No. of people examined (add 9 and 12 or 11 and 13)	13	18	35	66
Percentage infected with B. diphtheriæ, *i. e.* bacilli morphologically "typical"	23	11+	28+	23−
Percentage doubtful, *i. e.* infected with bacilli morphologically "atypical"	61+	72+	60+	63+
Percentage free of even suspicious forms	15+	17−	11+	14−

* See foot note page 516 this Report for interpretation of terms "typical" and "atypical."

The hospital contained 13 children suffering from chronic disturbances, such as otitis media, tuberculosis, appendicitis and skin affections. The receiving cottage contained 18 children who had recently come from different parts of the state. Here it was customary to house them for some time before assigning them to cottages for permanent occupation, with the idea of preventing the introduction of disease from the outside. Cottage V. contained boys of 6 to 18 years of age. The cultures were taken on October 7th between 10 and 12 a. m. The weather was fairly cool during shipment on October 7th to 9th, and they were incubated from the afternoon of the 9th until the morning of the 10th, and stained and examined on October 10th.

The above table shows the condition of affairs, which is not markedly different, except in degree from that shown in the previous table where cultures were taken shortly after dismissal of the children from the "filter." The percentage of infection with "typical" forms shows an increase in the hospital and Cottage V. over the general average of the previous examination, whilst in the receiving cottage, i. e., the cottage containing new arrivals, the percentage of infection of "typical" forms is lower than these, it is still quite marked. It will be observed that in the receiving cottage the percentage of infection with "atypical" forms only was greater than in either the hospital or Cottage V. The number of children examined, however, was perhaps not sufficiently large to warrant a thorough comparison between the conditions found at this time and those which had obtained 8 months before. One very striking point, however, is that at this time only 14 per cent of the children were free of all suspicious forms, whilst at the cessation of the investigation in March, 59 per cent had been shown to be free of every micro-organism resembling B. diphtheriæ.

A table of comparison between the results obtained at Owatonna and those which were found present in the children examined "en masse" in various other portions of the state is shown later in this report. (See page 542.)

SPECIAL INVESTIGATION OF PUBLIC SCHOOLS AT ALBERT LEA, MINN.

On Jan. 12, 1899, Dr. H. M. Bracken, secretary of the state board of health, visited Albert Lea to investigate conditions and determine if possible the reasons for the continued existence of a diphtheria epidemic which had been then over three months in progress. Though the schools had been closed at one time, it was

apparent that quarantine and other precautions had been at first far from rigid, and as a result inefficacious.†

The public schools which had been reopened were visited and cultures taken at random from various children in some of the rooms. The cultures taken (59 in all) included those from some of the teachers and the medical representative of the school board. Ten of the cultures were taken from the throat alone, and B. diphtheriæ was found in none, although one of the persons had been ill with diphtheria in October, 1898. From one of the children a culture taken only from the nose showed some *"atypical" forms of B. diphtheriæ. Unfortunately no parallel culture from the throat was available for comparison.

The remaining 48 cultures were taken from 24 individuals selected at random (synchronous cultures from both nose and throat). Three of the individuals had been ill with diphtheria in October and November, and two of them showed at this time "typical" diphtheria bacilli in the throat cultures. The following table gives the laboratory findings:

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†For history of this diphtheria epidemic, see Biennial Report State Board of Health, 1895-1898, pages 66, 71, 387 and 450.

*See foot note, page 516, this Report, for interpretation of terms "typical" and "atypical."

Table No. 14, Showing Distribution of Diphtheria-like Bacilli ("Typical"* and "Atypical") in the Throats and Noses of Certain of the Children in the Public Schools at Albert Lea, Minn., Some Weeks after an Epidemic of Diphtheria, During which the Schools were Closed and Afterwards Disinfected.‡ Cultures Taken Jan. 12, 1899.

1.	Number of persons showing *throat infected with "typical"* B. diphtheriæ (nose free of all diphtheria-like bacteria)...	5
2.	Number of persons showing *throats infected only with "atypical"* forms of B. diphtheriæ (nose free of all diphtheria-like bacteria)..	0
3.	Number of persons showing *nose infected with "typical"* B. diphtheriæ (throat free of all diphtheria-like bacteria)...................	0
4.	Number of persons showing *nose infected only with "atypical"* forms of B. diphtheriæ (throat free of all diphtheria-like bacteria).......	2
5.	Number of persons showing *both nose and throat infected with "typical"* B. diphtheriæ...........	1
6.	Number of persons showing both throat and nose infected only with "atypical" forms of B. diphtheriæ	0
7.	Number of persons showing *throat infected with "typical"* B. diphtheriæ, with *"atypical" forms only in the nose*.....	0
8.	Number of persons showing *throat infected only with "atypical" forms*, with "typical" B. diphtheriæ in the nose.................	0
9.	Total number of persons showing *infection in either nose or throat*, with "typical" B. diphtheriæ (add 1, 3, 5, 7 and 8)	6
10.	Total number of persons showing *infection in either nose or throat*, with "atypical" forms, all "typical" B. diphtheriæ being absent (add 2, 4 and 6)...	2
11.	Total number of persons showing infection in either nose or throat, with either "typical" B. diphtheriæ or suspicious forms (add 9 and 10)...	8
12.	Total number of persons *uninfected with "typical" B. diphtheriæ*, *i. e.*, showing no "typical" B. diphtheriæ in either nose or throat..	18
13.	Total number of persons *uninfected with even "atypical" forms* of B. diphtheriæ, *i. e.*, all suspicious forms absent from both nose and throat...........................	16
14.	Total number of people examined (add 9 and 12 or 11 and 13)........	24
	Percentage infected with B. diphtheriæ, *i. e.*, bacilli morphologically "typical"	25
	Percentage doubtful, *i. e.*, infected with bacilli morphologically "atypical"..	8+
	Percentage free of even suspicious forms..........................	66+

As will be seen, of the 24 persons examined. 6 (or 25 per cent) were found infected with "typical" diphtheria bacilli. For the sake of fairness it might perhaps be better to exclude the three persons who had been ill some months before with diphtheria. This leaves a balance of 4 persons out of 21 (or nearly 20 per cent) who showed infection with "typical" forms of B. diphtheriæ. Including the 2 who showed "atypical" forms there were 6 out of 21 (or 28 per cent) who might be regarded with suspicion, though in none of them was a history of diphtheria obtained. It

*See footnote p. 516 this Report for interpretation of terms "typical" and "atypical."
‡See Biennial Report, Minnesota State Board of Health, 1895 to 1898, p. 450, *et seq.*

will be noted that "atypical" forms occurred alone (i. e., without the presence of "typical" B. diphtheriæ in the same specimen) in the nose only in 2 cases. It is the rule for the "atypical" forms to be present more frequently in the nose than in the throat. Sixteen showed no diphtheria bacilli nor any suspicious forms.

Perhaps too few examinations were made to warrant the drawing of any general conclusions. A change in methods of quarantine, etc., was followed by a rapid disappearance of all the diphtheria cases.

SPECIAL INVESTIGATION OF PUBLIC SCHOOLS AT ELBOW LAKE, MINN., JAN. 23, 1899.

Dr. Bracken, in the investigation of methods of quarantine employed by the Elbow Lake Board of Health, then in the process of changing its membership, etc., visited the town on Jan. 23d. He took 76 cultures from 74 children. The examination of 4 cultures taken from 3 children not in attendance at school—one had cultures taken from both nose and throat—showed no diphtheria bacilli. In the schools cultures were taken from four different rooms or grades. As in only one case was a nose culture taken, as well as throat culture, it is impossible to tabulate results in a way uniform with those obtained at Albert Lea and elsewhere.

The following points seem worthy of mention:

1. Of the 74 children examined 15 showed the presence of "typical" B. diphtheriæ (14 in the throat and one in the nose of the only child from whom both nose and throat cultures were taken. His throat culture was negative.) That is to say, more than 20 per cent of the children were infected with "typical" B. diphtheriæ.

2. "Atypical" forms of B. diphtheriæ or suspicious bacilli were found in other children who did not show "typical" B. diphtheriæ.

3. The 15 children infected with "typical" B. diphtheriæ belonged to 15 different families, i. e., the names were all different.

4. Of the 4 infected only with suspicious forms 2 of them belonged to the same family, i. e, had the same name as 1 of the 15 infected with "typical" forms.

5. The 15 children infected with "typical" forms and 4 infected with "atypical" forms were distributed in the school as follows:

Room I., 20 children examined showed 3 infected with "typical" forms.

Room II., 37 children examined showed 8 infected with "typical and 2 with "atypical."

Room III (second primary), 7 children examined showed 3 infected with "typical" and 3 with "atypical" forms.

Room IV. (first primary), 5 children examined showed 1 infected with "typical" forms.

6. Of the infected children 5 on enquiry were found to belong to families in which illness, and death in two instances, had occurred. The illness had been diagnosed as membranous croup or had not been given a name.

7. The relatively small amount of infection with "atypical" forms is very marked and may be due perhaps to the fact that only two nose cultures were taken. These bacilli are more abundant as a rule in nose cultures. That nose cultures were not taken would also have a tendency to reduce the total amount of infection with "typical" forms, since many times these are present in the nose culture when absent from that taken from the throat. (See summary and comparison of results of all special investigations in this Report, page 542 et seq.)

PRELIMINARY INVESTIGATION OF STATE SCHOOL FOR THE FEEBLE-MINDED, FARIBAULT, MINN.

The special investigation of the State Public School for Dependent and Neglected Children at Owatonna having shown a condition of affairs which was altogether unexpected, it seems advisable to determine whether other public institutions which were comparable, so far as method of living, etc., were concerned, were in the same condition. Whilst the State School for the Feeble Minded, owing to the mental condition of its inhabitants, presents a different kind of life, it has three things in common with that of the State Public School for Dependent and Neglected Children, namely:

1. The children are housed together, and those of them in the School for the Feeble Minded who are in a condition to receive an education are educated at the school.

2. In both institutions the inhabitants are mainly children.

3. The hygienic conditions, the care bestowed upon the children, etc., are of the very best in both institutions. At Owatonna the child population changes to a greater extent than is the case in the institution at Faribault.

Through the kindness of Dr. Rogers, superintendent of the School for the Feeble Minded, permission was given to make an investigation of the condition of the noses and throats of the inmates of the school. On March 19, 1899, Dr. L. B. Wilson, first assistant bacteriologist of this laboratory, visited the institution and collected specimens from the throats and noses of fifty of the inmates, as follows:

1. Twelve boys selected at random from the lowest grade of the custodial department. This department contains only idiots of the lowest type. All must be under the care of an attendant at all times.

2. Cultures were taken from 15 girls selected at random from the custodial department.

3. From each of a class of 12 boys, whose mental condition was such as to permit them to receive instruction in the school department, specimens were taken.

4. From each of a class of 11 girls in the highest grade of the school department cultures were also taken.

The condition of the boys and girls in these classes of the school department is, of course, markedly different from that of those in the custodial department.

The following table gives the result of the laboratory examinations:

Table No. 15, Showing Distribution of Diphtheria and Diphtheria-like Bacilli ("Typical" and "Atypical") in the Throats and Noses of Certain Inmates of the State School for the Feeble Minded, Faribault, no Clinical Diphtheria having Occurred in the School for Several Months. Cultures Taken March 18, 1899.

	12 Boys Lowest Grade of Custodial Dept.	15 Girls From Custodial Dept.	Boys' Class From School Dept.	Girls of Highest Grade School Dept.	Total.
1. Number of persons showing *throat infected with "typical" B. diphtheriæ* (nose free of diphtheria-like bacteria)	0	1	0	0	1
2. Number of persons showing *throat infected only with "atypical"* forms of *B. diphtheriæ* (nose free of all diphtheria-like bacteria)	1	0	0	0	
3. Number of persons showing *nose infected with "typical" B. diphtheriæ* (throat free of all diphtheria-like bacteria)	0	0	0	0	0
4. Number of persons showing *nose infected only with "atypical"* forms of *B. diphtheriæ* (throat free of all diphtheria-like bacteria)	3	4	6	3	16
5. Number of persons showing *both throat and nose infected with "typical" B. diphtheriæ*	0	0	0	0	0
6. Number of persons showing *both throat and nose infected only with "atypical"* forms of *B. diphtheriæ*	5	2	2	4	13
7. Number of persons showing *throat infected with "typical" B. diphtheriæ* with *"atypical" forms only in the nose*	1	0	0	0	1
8. Number of persons showing *throat infected only with "atypical" forms* with *"typical" B. diphtheriæ in the nose*	0	1	0	0	1
9. Total number of persons showing *infection in either nose or throat with "typical" B. diphtheriæ* (add 1, 3, 5, 7 and 8)	1	2	0	0	3
10. Total number of persons showing *infection in either nose or throat with "atypical" forms, all "typical" B. diphtheriæ being absent* (add 2, 4 and 6)	9	6	8	7	30
11. Total number of persons showing *infection in either nose or throat with either "typical" B. diphtheriæ or suspicious forms* (add 9 and 10)	10	8	8	7	33
12. Total number of persons *uninfected with "typical" B. diphtheriæ i. e.*, showing no "typical" *B. diphtheriæ* in either nose or throat	11	13	12	11	47
13. Total number of persons *uninfected with even "atypical" forms* of *B. diphtheriæ*, *i. e.*, all suspicious forms absent from both nose and throat	2	7	4	4	17
14. Total number of people examined (add 9 and 12 or 11 and 13)	12	15	12	11	50
Percentage infected with *B. diphtheriæ, i. e.*, bacilli morphologically "typical"	8+	13+	0	0	6
Percentage doubtful, *i. e.*, infected with bacilli morphologically "atypical"	75	40	67—	64	60
Percentage free of even suspicious forms	17—	47—	33+	36	34

* See foot note page 516 this Report for interpretation of terms "typical" and "atypical."

A study of this table shows that amongst the lowest grade of boys and girls in the custodial department "typical" forms of B. diphtheriæ were found in 3 of the 27 children examined. In neither boys and girls from the school department were "typical" forms found at all. The "atypical" forms were present in almost as great abundance in the children of the higher grade as in the lower, those showing the least amount of infection with the "atypical" forms being the girls in the custodial department. The general percentage of infection, however, with the "typical" forms is far less than that observed in the State Public School for Dependent and Neglected Children at Owatonna. There had been no clinical diphtheria in the School for the Feeble-Minded for over four months. The opportunities for outside infection at the School for the Feeble-Minded seem to be less than at the State Public School for Dependent and Neglected Children for at least two reasons:

1. There is less change in the school population, i. e., fewer admissions, and they are much less frequently sent out to homes in the state and again returned.

2. After admission to the School for the Feeble-Minded, they have no opportunity for mixing with the outside world, whilst at Owatonna the older children attend the town schools.

SPECIAL INVESTIGATION OF THE CHILDREN IN THE PUBLIC SCHOOLS AT FARIBAULT, MINN.

At the time of the visit of Dr. Wilson to Faribault, through the kindness of Dr. Rogers and the local school board, opportunity was afforded for the collection of specimens from some of the school children. The cultures were taken from all the children in the second and seventh grades of one building. The children of the second grade were from 7 to 9 years old, and came from the best families living in the central portion of the town. The children in the seventh grade were from homes distributed in all parts of the city, and varied from 13 to 15 years in age. Some of the children in the seventh grade came from a district in which the only case of diphtheria known to be in town was located.

The following table gives the results of the laboratory findings:

Table No. 16, Showing Distribution of Diphtheria and Diphtheria-like Bacilli ("Typical" and "Atypical") in the Throats and Noses of Children in City Public Schools, Faribault, Minn., only One Case of Diphtheria having been Reported in Town at the Time of the Taking of the Cultures on March 19, 1899.

	2d Grade Children, 7 to 9 Years Old—Best Grade Families from Central Part of Town.	7th Grade Children, 13 to 15 Y'rs Old—Families from All Over Town.	Total.
1. Number of persons showing *throat infected with "typical"* B. diphtheriæ (nose free of all diphtheria-like bacteria)	1	0	1
2. Number of persons showing *throat infected only with "atypical"* forms of B. diphtheriæ (nose free of all diphtheria-like bacteria)	1	3	4
3. Number of persons showing *nose infected with "typical"* B. diphtheriæ (throat free of all diphtheria-like bacteria)	2	1	3
4. Number of persons showing *nose infected only with "atypical"* forms of B. diphtheriæ (throat free of all diphtheria-like bacteria)	5	6	11
5. Number of persons showing *both throat and nose infected with "typical"* B. diphtheriæ	2	0	2
6. Number of persons showing *both throat and nose infected only with "atypical"* forms of B. diphtheriæ	4	2	6
7. Number of persons showing *throat infected with "typical" B. diphtheriæ* with *"atypical" forms only in the nose*	0	0	0
8. Number of persons showing *throat infected only with "atypical" forms* with *"typical" B. diphtheriæ in the nose*	0	0	0
9. Total number of persons showing *infection in either nose or throat with "typical" B. diphtheriæ* (add 1, 3, 5, 7 and 8)	5	1	6
10. Total number of persons showing *infection in either nose or throat with "atypical" forms, all "typical" B. diphtheriæ being absent* (add 2, 4 and 6)	11	11	22
11. Total number of persons showing *infection in either nose or throat with either "typical" B. diphtheriæ or suspicious forms* (add 9 and 10)	16	12	28
12. Total number of persons *uninfected with "typical" B. diphtheriæ*, *i. e.*, showing no "typical" B. diphtheriæ in either nose or throat	20	31	51
13. Total number of persons *uninfected with even "atypical" forms* of B. diphtheriæ, *i. e.*, all suspicious forms absent from both nose and throat	9	20	29
14. Total number of people examined (add 9 and 12 or 11 and 13)	25	32	57
Percentage infected with B. diphtheriæ, *i. e.*, bacilli morphologically "typical"	20	3+	10+
Percentage doubtful, *i. e.* infected with bacilli morphologically "atypical"	44	34+	37—
Percentage free of even suspicious forms	36	62+	53—

The preceding table shows that the children of the second grade were more widely infected with "typical" forms than those in the seventh grade, the proportion being 5 out of 25 and 1 out of 32, or 20 and 3 per cent practically. The first specimen examined from the first child, who was in the second grade, showed a nearly pure culture of B. diphtheriæ. In each of the other 4 cases reported from this room, only a few "typical" bacilli were found. It is interesting to note that none of the children who lived in the part of town in which the case of clinical diphtheria then existed showed infection with the "typical" forms. The children who came from well-to-do families in the central portion of the town showed greater infection with the "typical" forms than those whose homes were more widely scattered. Whether the question of respective ages, or the fact that those showing the greatest infection lived in the central portion of the town, and consequently more closely together, has anything to do with this or not cannot be stated. The percentage of infection with "atypical" forms did not differ very greatly in the two groups of children. Of the total number of 6 children who were infected with "typical" forms, 3 of them showed infection of the throat, of which 2 were infected in both nose and throat. Three of the 6 were infected with the "typical" bacilli in the nose and showed no infection in the throat at all. If cultures had been taken from the throat alone in these cases, 3 only would have shown infection with the "typical" forms.

SPECIAL INVESTIGATION OF TOWN PUBLIC SCHOOLS AT OWATONNA, MINN., OCT. 6, 1899.

On Oct. 6, 1899, Dr. O. McDaniel, whilst collecting specimens, etc., from the State Public School for Dependent and Neglected Children, took cultures from certain of the children in the town public schools at Owatonna, with the assistance of Dr. Adair and the endorsement and approval of the school authorities. At this time, so far as could be determined, there were no clinical cases of diphtheria in Owatonna. However, the possibility of the occurrence of mild cases a short time before cannot be excluded. Cultures were taken from the children in the first and second ward public schools. In the first ward public school 4 or 5 children (volunteers) from each room were examined. The children were from 7 to 14 years of age. The cultures were taken by Dr. Adair. The second ward public school cultures (4 or 5 children from each room volunteered) were taken by Dr. McDaniel, and the children were about the same ages as in the other school.

The following table gives the result of the laboratory findings:

Table No. 17, Showing Distribution of Diphtheria and Diphtheria-like Bacilli ("Typical" and "Atypical") in the Throats and Noses of Children in the Town Public Schools at Owatonna, Minn., Oct. 6, 1899.

	First Ward Public School.	Second Ward Public School.	Totals.
1. Number of persons showing *throat infected with "typical"* B. diphtheriæ (nose free of all diphtheria-like bacteria)..	0	1	1
2. Number of persons showing *throat infected only with "atypical"* forms of B. diphtheriæ (nose free of all diphtheria-like bacteria)........	1	1	2
3. Number of persons showing *nose infected with "typical"* B. diphtheriæ (throat free of all diphtheria-like bacteria)........	0	0	0
4. Number of persons showing *nose infected only with "atypical"* forms of B. diphtheriæ (throat free of all diphtheria-like bacteria)........	7	3	10
5. Number of persons showing *both throat and nose infected with "typical"* B. diphtheriæ........	0	0	0
6. Number of persons showing *both throat and nose infected only with "atypical"* forms of B. diphtheriæ........	2	8	10
7. Number of persons showing *throat infected with "typical" B. diphtheriæ* with *"atypical" forms only in the nose*........	0	0	0
8. Number of persons showing *throat infected only with "atypical" forms* with *"typical" B. diphtheriæ in the nose*........	0	1	1
9. Total number of persons showing *infection in either nose or throat with "typical" B. diphtheriæ* (add 1, 3, 5, 7 & 8)	0	2	2
10. Total number of persons showing *infection in either nose or throat with "atypical" forms*, all "typical" B. diphtheriæ being absent (add 2, 4 and 6)........	10	12	22
11. Total number of persons *showing infection in either nose or throat with either "typical" B. diphtheriæ or suspicious forms* (add 9 and 10)........	10	14	24
12. Total number of persons *uninfected with "typical" B. diphtheriæ, i. e.*, showing no "typical" B. diphtheriæ in either nose or throat........	19	19	38
13. Total number of persons *uninfected with even "atypical" forms* of B. diphtheriæ, *i. e.*, all suspicious forms absent from both nose and throat........	9	7	16
14. Total number of people examined (add 9 and 12 or 11 and 13)........	19	21	40
Percentage infected with B. diphtheriæ, *i. e.*, bacilli morphologically "typical"........	0	9+	5
Percentage doubtful, *i. e.*, infected with bacilli morphologically "atypical"........	53	57	55
Percentage free of even suspicious forms........	47	33+	40

This table shows that "typical" forms of B. diphtheriæ were not found at all in any of the children of the First Ward Public School in the 19 examined; 10 of them showed various "atypical" forms, of which 7 showed them in the nose and not in the throat, 1 in the throat and not in the nose and 2 showed bacilli common to both throat and nose; 9 were free of every suspicious bacillus. Children of the Second Ward Public School showed two individuals with "typical" bacilli present. Of these two, one had the bacilli in the throat and not in the nose, and the other showed "typical" forms in the nose with "atypical" forms in the throat. Twelve out of 21 children examined showed the presence of "atypical" forms and 7 were free of all forms. It may be mentioned that in the two cases which showed the "typical" forms the bacilli were very few in number and the findings comparable to those in clinical cases of diphtheria during convalesence when the diphtheria bacilli are disappearing from the throat. They were, nevertheless, present. The total percentage of infection with "typical" forms is lower amongst these children than in any of the investigations previously recorded.

SPECIAL INVESTIGATION OF UNION SCHOOL, MANKATO, MINN., NOV. 14, 1899.

About eight weeks prior to this investigation five cases of clinical diphtheria had developed in this school. The teacher also was slightly infected and was quarantined for three weeks. It was deemed wise to close the school for two weeks, and Dr. J. S. Holbrook, H. O., was anxious that nothing be left undone to ensure the safety of the children and prevent the further spread of the disease. Dr. Wilson of this laboratory visited Mankato on Nov. 14, 1899, and, with Dr. Holbrook, collected the specimens. Owing to the fact that the supply of culture media was exhausted, specimens were collected from only thirty out of thirty-five children in the primary class in which the age varied from seven to nine years. There were no clinical cases of diphtheria in the town or in the school at this time.

The following table gives the result of the laboratory findings:

Table No. 18, Showing Distribution of Diphtheria and Diphtheria-like Bacilli ("Typical" and "Atypical") in 30 Children Aged 7 to 9 in the Primary Class, Union School, Mankato, Minn., about 8 weeks after the Occurrence of 5 Cases of Diphtheria in the School which had been closed for 2 Weeks. No Cases in the School at Time that the Cultures were taken on Nov. 14, 1899.

1.	Number of persons showing *throat infected with "typical" B.* diphtheriæ (nose free of diphtheria-like bacteria)........	0
2.	Number of persons showing *throat infected only with "atypical"* forms of B. diphtheriæ (nose free of all diphtheria-like bacteria)...	1
3.	Number of persons showing *nose infected with "typical" B.* diphtheriæ (throat free of all diphtheria-like bacteria)..........	0
4.	Number of persons showing *nose infected only with "atypical"* forms of B. diphtheriæ (throat free of all diphtheria-like bacteria)......	13
5.	Number of persons showing *both throat and nose infected with "typical"* B. diphtheriæ.................	1
6.	Number of persons showing *both throat and nose infected only with "atypical"* forms of B. diphtheriæ............................	7
7.	Number of persons showing *throat infected with "typical" B. diphtheriæ* with *"atypical" forms only in the nose*............	0
8.	Number of persons showing *throat infected only with "atypical" forms* with *"typical" B. diphtheriæ in the nose*.................	0
9.	Total number of persons showing *infection in either nose or throat with "typical" B. diphtheriæ* (add 1, 3, 5, 7 and 8)...............	1
10.	Total number of persons showing *infection in either nose or throat with "atypical forms, all "typical" B. diphtheriæ being absent* (add 2, 4 and 6)........................	21
11.	Total number of persons showing *infection in either nose or throat with either "typical" B. diphtheriæ or suspicious forms* (add 9 and 10)..	22
12.	Total number of persons *uninfected with "typical" B. diphtheriæ, i. e.* showing no "typical" B. diphtheriæ in either nose or throat...	29
13.	Total number of persons *uninfected with even "atypical" forms* of B. diphtheriæ, *i. e.* all suspicious forms absent from both nose and throat..........	8
14.	Total number of people examined (add 9 and 12 or 11 and 13.).......	30
	Percentage infected with B. diphtheriæ, *i. e.* bacilli morphologically "typical"..	3+
	Percentage doubtful, *i. e.* infected with bacilli morphologically "atypical"...	70
	Percentage free of even suspicious forms........................	27—

As will be seen, the "typical" forms were present only once, and in this case the forms C^2, D^2, B^1 (see plates, page 635) this Report) were found in both throat and nose of the individual. As indicated by this statement, the new classification of types was employed in this investigation. From this time forward it was used in every case, but it seemed best to express the results of these later investigations in the terms employed for the earlier ones in order that comparison may be made. This case reported as "typical" would not ordinarily be so classed except perhaps in a clinical case where the throat had shown infection with B diphtheriæ and was being examined for release of quarantine. The percentage of infection with "atypical" forms was large here—70 per cent. In this investigation too few cultures were taken to warrant the drawing of very definite conclusions. The percentage of infection with "typical" forms, however, is less here than in any other investigation recorded in this report.

SPECIAL INVESTIGATION BETHANY HOME, MINNEAPOLIS, MINN., APRIL 9 and 11 AND MAY 14, 1900.

Bethany Home is a well conducted charitable institution where women are received before and cared for during and for a time after confinement. They may be admitted several months before confinement, and must, as a rule, agree to remain for a year after admission. Foundling children are also here cared for. The mothers make themselves useful in the general work of the institution; that is, in the housework, care of the infants, etc. Usually during the day all the young babies are kept in one room, three or four of the adult inmates remaining to assist the regular nurses in the care of the babies.

During the day when certain of the mothers are engaged in housework or in the kitchen or laundry, the care of their babies devolves upon certain of the other mothers. Where, for any cause, a mother is unable to nurse her own child, it sometimes happens that one of the other mothers may suckle it for all or a portion of the time. Where the mothers are engaged in work they may go back to the nursery from time to time and suckle their own children. It will thus be seen that the institution life is such as to afford the very best opportunities for the general distribution of diphtheria bacilli should they gain access to the Home.

The names of the inmates of the institution are not publicly known and the tabulation of records by the laboratory was found

somewhat difficult. In the beginning of April, 1900, a woman in labor was admitted to the institution. Shortly after confinement and before leaving her bed she developed severe laryngeal diphtheria and died after removal to the City Hospital. So far as could be ascertained there was little or no possibility of general infection from this particular case, though two other cases of mild diphtheria developed. One of them was an attendant of the Home and was subject to frequent sore throat. One of the two later patients (adult) was taken to the City Hospital, and the other (child) was isolated in the annex building. These conditions led the matron and Dr. Martha B. Moorhead, attending physician to the Home, to desire an investigation to determine how widespread the infection might be. Accordingly, Dr. McDaniel of this laboratory took cultures from the throats and noses of all the inmates, attendants, nurses and adult workers (124 in all) on April 9 and 11, 1900. Investigation and recommendations were made after consultation with the Commissioner of Health of Minneapolis, to whom a report of conditions was made. The examinations made at this time were of specimens from—

1. Babies from six months to three years old.
2. Adults consisting of mothers, attendants and nurses in association with the babies in group 1.
3. Young babies under six weeks old.
4. Adults, that is, mothers, attendants, etc., in association with the young babies.
5. Children with whooping cough who were confined in the sick nursery.
6. The inmates of the annex building, which was at some distance from the main building and to which, as a rule, the meals were brought from the main Home. The inmates here consisted of children about five years old. The adults associated with them are included in group 2. The children in this group were examined on the second visit on April 11th.

The following table indicates the condition of affairs found upon the examination of the specimens in the laboratory:

Table No. 19, Showing Distribution of Diphtheria and Diphtheria-like Bacilli ("Typical" and "Atypical") in the Apparently Healthy Inmates of Bethany Home, Minneapolis, Immediately After the Discovery of One Severe and Two Mild Cases of Clinical Diphtheria. Cultures Taken April 9 and 11, 1900.

	Babies 6 Months to 3 Years.	Adults (Mothers and Attendants) in Associat'n with Them.	Young Babies (Under 6 Weeks).	Adults Associated with Young Babies.	Babies with Whooping Cough in "Sick Nursery."	Annex—Children About 5 Years Old.	Total.
1. Number of persons showing *throat infected with "typical"* B. diphtheriæ (nose free of diphtheria-like bacteria)	2	4	0	1	0	2	9
2. Number of persons showing *throat infected only with "atypical"* forms of B. diphtheriæ (nose free of all diphtheria-like bacteria)	0	1	0	0	0	0	1
3. Number of persons showing *nose infected with "typical"* B. diphtheriæ (throat free of all diphtheria-like bacteria)	5	9	3	0	2	1	20
4. Number of persons showing *nose infected only with "atypical"* forms of B. diphtheriæ (throat free of all diphtheria-like bacteria)	6	4	0	1	1	0	12
5. Number of persons showing *both throat and nose infected with "typical"* B. diphtheriæ	4	7	0	2	0	1	14
6. Number of persons showing *both throat and nose infected only with "atypical"* forms of B. diphtheriæ	0	3	0	0	0	0	3
7. Number of persons showing *throat infected with "typical" B. diphtheriæ* with *"atypical" forms only in the nose*	2	0	0	0	0	0	2
8. Number of persons showing *throat infected only with "atypical" forms* with *"typical" B. diphtheriæ in the nose*	0	2	0	0	0	0	2
9. Total number of persons showing *infection in either nose or throat with "typical" B. diphtheriæ* (add 1, 3, 5, 7 and 8)	13	22	3	3	2	4	47
10. Total number of persons showing *infection in either nose or throat with "atypical" forms, all "typical" B. diphtheriæ being absent* (add 2, 4 and 6)	6	8	0	1	1	0	16
11. Total number of persons showing *infection in either nose or throat with either "typical" B. diphtheriæ or suspicious forms* (add 9 and 10)	19	30	3	4	3	4	63
12. Total number of persons *uninfected with "typical" B. diphtheriæ*, *i. e.*, showing no "typical" B. diphtheriæ in either nose or throat	25	35	5	5	4	3	77
13. Total number of persons *uninfected with even "atypical" forms* of B. diphtheriæ, *i. e.*, all suspicious forms absent from both nose and throat	19	27	5	4	3	3	61
14. Total number of people examined (add 9 and 12 or 11 and 13)	38	57	8	8	6	7	124
Percentage infected with B. diphtheriæ, *i. e.*, bacilli morphologically "typical"	34+	38+	37+	37+	33+	57	38—
Percentage doubtful, *i. e.*, infected with bacilli morphologically "atypical"	16—	14	0	12+	17—	0	13—
Percentage free of even suspicious forms	50	47+	62+	50	50	43—	49

The examinations made were recorded in the terms of the new classification; i. e., A, B, C, D, etc.;* but it seemed better to utilize the old terms "typical" and "atypical" for comparison at this time.

This table shows a very high percentage of infection with "typical" forms, higher than in any of the previous investigations. Forty-seven out of a total of 124 were thus infected, or 38 per cent. It was frequently found that both mother and child were infected with "typical" forms. Babies even a few hours old showed their presence. In this investigation, if throat cultures alone had been taken, only twenty-five of the inmates would have shown infection with the "typical" forms. (Add 1, 5 and 7 of table to determine the total number of throats infected.) In other words, twenty-two of the inmates showed the "typical" forms present in the nose and not in the throat. (Add 3 and 8 of this table.) It may be mentioned that in many of the cases reported as showing "typical" diphtheria bacilli the findings showed the forms most usually present and in the same combination (C, A, D) as those found in "typical" clinical cases. The records of ten of the cases show that B. diphtheriæ was present in nearly pure culture.

The percentage of infection with "atypical" forms is uniformly low throughout and absent entirely in the young babies and in the children in the annex building. The total of 13 per cent of infection with "atypical" forms ("typical" forms being absent entirely) is less than that reported in any of the previous investigations. After the clinical cases were removed to the City Hospital the premises were disinfected and gargling with cleansing and disinfecting solution prescribed for all persons in the Home. Separation of the infected from the uninfected was impracticable, but notwithstanding this no other cases developed.

On May 14th, five weeks later, cultures were again taken from all the inmates, with the results expressed in the following table:

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*For a comparison of the two examinations made at Bethany Home, expressed in terms of the "type" classification, see p 650, this Report.

Table No. 20, Showing Distribution of Diphtheria and Diphtheria-like Bacilli ("Typical" and "Atypical") in the Inmates of Bethany Home, Minneapolis, Five Weeks After the Discovery and Removal of Three Clinical Cases of Diphtheria, no New Cases Developing in the Meantime. Cultures Taken May 14, 1900.

	Babies, 6 Months to 6 Years Old.	Adults (Mothers and Attendants) in Association with Them.	Babies Under 6 Weeks Old.	Adults Associated with Young Babies.	Total.
1. Number of persons showing *throat infected with "typical"* B. diphtheriæ (nose free of all diphtheria-like bacteria)...........	0	1	0	0	1
2. Number of persons showing *throat infected only with "atypical"* forms of B. diphtheriæ (nose free of all diphtheria-like bacteria)................................	0	0	0	0	0
3. Number of persons showing *nose infected with "typical"* B. diphtheriæ (throat free of all diphtheria-like bacteria)...........	9	5	2	2	18
4. Number of persons showing *nose infected only with "atypical" forms of* B. diphtheriæ (throat free of all diphtheria-like bacteria)................................	6	5	2	0	13
5. Number of persons showing *both throat and nose infected with "typical"* B. diphtheriæ....................................	1	1	0	0	2
6. Number of persons showing *both throat and nose infected only with "atypical"* forms of B. diphtheriæ	1	1	0	0	2
7. Number of persons showing *throat infected with "typical" B. diphtheriæ* with *"atypical" forms only in the nose*...............	0	0	0	0	0
8. Number of persons showing *throat infected only with "atypical" forms* with *"typical" B. diphtheriæ in the nose*............	1	0	0	0	1
9. Total number of persons showing *infection in either nose or throat with "typical" B. diphtheriæ* (add 1, 3, 5, 7 and 8)...........	11	7	2	2	22
10. Total number of persons showing *infection in either nose or throat with "atypical" forms, all "typical" B. diphtheriæ being absent* (add 2, 4 and 6).....................	7	6	2	0	15
11. Total number of persons showing *infection in either nose or throat with either "typical" B. diphtheriæ or suspicious forms* (add 9 and 10)............................	18	13	4	2	37
12. Total number of persons *uninfected with "typical" B. diphtheriæ, i. e.*, showing no "typical" B. diphtheriæ in either nose or throat...	39	44	7	6	96
13. Total number of persons *uninfected with even "atypical" forms* of B. diphtheriæ, *i. e.*, all suspicious forms absent from both nose and throat.....................	32	38	5	6	81
14. Total number of people examined (add 9 and 12 or 11 and 13)........................	50	51	9	8	118
Percentage infected with B. diphtheriæ, *i. e.*, bacilli morphologically "typical" ...	22	14—	22+	25	19—
Percentage doubtful, *i. e.*, infected with bacilli morphologically "atypical".......	14	12+	22+	0	12+
Percentage free of even suspicious forms.	64	74+	55+	75	69—

The constant moving about of the inmates in the Home, change, etc., of the Home population, together with the fact that no record by name or number is permitted to go outside of the Home, made it impossible to group the individuals in the second examination precisely as they had been in the first examination.

The following points may be seen from the table:

1. The total infection with "typical" forms had decreased to 19 per cent, i. e., just half that recorded in the first investigation.

2. The percentage of infection with "atypical" forms remained practically the same, in the first examination being 13– and in the second examination 12+.

3. In the first examination the people infected with "atypical" forms alone, bore the ratio of 13 to 38 when compared with the people infected with "typical" forms. In the second examination the proportion was 12+ to 19–. This means a relative though not actual increase in the percentage of infection with "atypical" forms alone. The condition of affairs in the second examination is therefore more nearly comparable to the results obtained in the other investigation here recorded.

4. The percentage of the inmates absolutely free of all suspicious forms had increased from 49 to 69.

5. At the time of the first investigation, out of the 47 people who showed the presence of "typical" forms, 25 alone showed these bacilli in the throat. In the second examination, out of a total of 22 showing infection with "typical" forms, only three had these bacilli in the throat, so that the condition of the throats so far as the presence of the "typical" forms is concerned was very markedly different at the time of the first and second examinations, the percentage of infection being 25:3. This marked disappearance of the "typical" forms from the throat is probably due, to some extent at least, to the thorough treatment with gargles, etc., to which all the inmates were subjected.

6. The second examination showed relatively a far higher proportion of nose infection than throat infection. In the first examination, out of a total of 47 people who showed infection with the "typical" forms, 14 showed infection in both nose and throat, 11 showed throat infection only, and 22 showed infection in the nose and not in the throat. In the second examination 2 showed both nose and throat infected, one showed only throat infection, and 19 showed the nose infected whilst the throat was free. In other words, in the last examination the total number of noses infected with "typical" bacilli was 21, and the total throats infect-

ed with these bacilli was 3. In both examinations, out of the total number of people infected in either throat or nose with "typical" forms, 36 showed infection in the nose and 25 in the throat. The importance of taking nose as well as throat cultures will be appreciated by a study of these figures.

The special investigations made to determine the distribution of diphtheria and diphtheria-like bacilli during 1899 and 1900 can be roughly divided into two classes, namely: those in which specimens were collected from:

1. The day scholars of the public schools in certain of the smaller cities and towns of the state. In all these the children were brought together in masses only during a portion of the day for five days a week.

2. Where cultures were taken from the inmates of institutions in which they remained, not only during the day, but were housed together and in certain of them educated. Amongst the inhabitants of these institutions it is easily seen that the opportunities for the introduction and dissemination of infection are much greater than amongst the day scholars. This is particularly true in Bethany Home and the State Public School for Dependent and Neglected Children. In all of the institutions the inhabitants come from much more widely scattered localities than is the case with the scholars in the public schools.

It is apparent then that the inhabitants of the institutions are likely to be infected from some new arrival, whilst after their arrival infection from outside sources is less likely to occur than in the town public schools, where the children are only in school for a small portion of their time.

From the following table a comparison of the total results obtained in each institution is possible:

Table No. 21, Showing Distribution of Diphtheria and Diphtheria-like Bacilli ("Typical" and "Atypical") in all of the Special Investigations Made During 1899 and 1900.

	Public Schools, Albert Lea, Jan. 2, 1899.	Public Schools, Elbow Lake, Jan. 24, 1899.	Public Schools, Faribault, March 19, 1899.	Public Schools, Owatonna, Oct. 6, 1899.	Public Schools, Mankato, Nov. 14, 1899.	Total for Public Schools.	State Pub. School for Dependent and Neglected Children, March, 1899.	State Pub. School for Dependent and Neglected Children, Oct. 7, 1899.	State School for the Feeble Minded March 18, 1899.	Bethany Home, April 9 and 11, 1900.	Bethany Home, May 14, 1900.	Total for Institutions and Homes.	Total for All Special Investigations Made During 1899-1900 which are at all Comparable.
1. No. of persons showing *throat infected with "typical"* B. diphtheriæ (nose free of all diphtheria-like bacteria)........	5	....	1	1	0	7	2	3	1	9	1	14	21
2. No. of persons showing *throats infected only with "atypical"* forms of B. diphtheriæ (nose free of all diphtheria-like bacteria)........	0	....	4	2	1	7	2	3	1	1	0	7	14
3. No. of persons showing *nose infected with "typical"* B. diphtheriæ (throat free of all diphtheria-like bacteria)........	0	....	3	0	0	3	11	1	0	20	18	50	53
4. No. of persons showing *nose infected only with "atypical"* forms of B. diphtheriæ (throat free of all diphtheria-like bacteria)........	2	....	11	10	13	36	41	10	16	12	13	92	128
5. No. of persons showing *both nose and throat infected with "typical"* B. diphtheriæ........	1	....	2	0	1	4	4	4	0	14	2	24	28
6. No. of persons showing both throat and nose infected only with "atypical" forms of B. diphtheriæ........	0	....	6	10	7	23	9	29	13	3	2	56	79
7. No. of persons showing *throat infected with "typical"* B. diphtheriæ, with "atypical" forms only in the nose........	0	....	0	0	0	0	7	6	1	2	0	16	16
8. No. of persons showing *throat infected only with "atypical" forms with* "typical" B. diphtheriæ in the nose........	0	....	0	1	0	1	3	1	1	2	1	8	9
9. Total No. of persons showing *infection in either nose or throat with* "typical" B. diphtheriæ. (add 1, 3, 5, 7 and 8)........	6	(15)	6	2	1	15	27	15	3	47	22	114	129
10. Total No. of persons showing *infection in either nose or throat with* "atypical" forms, all "typical" B. diphtheriæ being absent (add 2, 4, 6)...	2	....	22	22	21	67	52	42	30	16	15	155	222
11. Total No. of persons showing infection in either nose or throat with either "typical" B. diphtheriæ or suspicious forms (add 9 and 10)......	8	....	28	24	22	82	79	57	33	63	37	269	351
12. Total No. of persons *uninfected with "typical" B. diphteriæ, i. e.,* showing no "typical" B. diphtheriæ in either nose or throat........	18	....	51	38	29	136	166	51	47	77	96	437	573
13. Total No. of persons *uninfected with even "atypical" forms* of B. diphtheriæ, *i. e.*, all suspicious forms absent from both nose and throat..	16	....	29	16	8	69	114	9	17	61	81	282	351
14. Total No. of people examined (add 9 and 12 or 11 and 13)	24	(74)	57	40	30	151	198	66	50	124	118	551	702
Percentage infected with B. diphtheriæ, *i. e.*, bacilli morphologically "typical"........	25	(20+)	10+	5	3+	10—	14	23—	6	38—	19—	20	18+
Percentage doubtful, *i. e.*, infected with bacilli morphologically "atypical"........	8+	....	37—	55	70	44+	27	63+	60	13—	12+	28	32—
Percentage free of even suspicious forms........	66+	....	53—	40	27—	46—	59	14—	34	49	69—	51	50

The conditions in the various towns are not perhaps parallel. In Albert Lea diphtheria had been very prevalent. Some of the teachers, as well as the children, had suffered from clinical diphtheria. The quarantine period had not been sufficient, as was evidenced by the fact that in certain of those who had been suffering from diphtheria and had returned to school diphtheria bacilli were still found.

At Elbow Lake, owing to the fact that cultures were taken from the throat only, an accurate comparison cannot be made, though 20 per cent, that is 15 out of 74, showed the presence of "typical" forms, and had nose cultures been taken throughout it is probable that this percentage of infection would have been higher. Here quarantine does not seem to have been rigidly enforced, because, upon inquiry, several of the children were found to belong to families in which clinical diphtheria and in some cases death from clinical diphtheria had occurred.

Albert Lea and Elbow Lake are therefore quite comparable in the respects that clinical diphtheria had been and was at that time in progress, and the enforcement of quarantine had been ineffective up to that period.

In these two schools infection with "typical" forms was much more marked than in the other three examined. The children of the public schools at Faribault showed infection of 10 per cent of their number with "typical" forms. As has been before mentioned, one case of diphtheria was in existence at the time of the taking of the specimens. Amongst the children who came from the neighborhood of this case of diphtheria, no "typical" forms were found present. In the public schools at Owatonna only 5 per cent of the children examined showed the presence of "typical" forms. No clinical diphtheria was known to exist at the time, though a number of mild sore throats had occurred in the town. The schools at Mankato showed but one case in which "typical" forms were found present, that is, less than 3 per cent of infection. In this case the types found present (C2,D2.B1) were not those most frequently found in "typical" clinical cases, according to the experience of this laboratory, though certain of the types present are frequently pictured in text books as types of B. diphteriæ.

1. CHILDREN ATTENDING PUBLIC DAY SCHOOLS.

In the examination of pupils of the public day schools of the towns investigated, though examinations were perhaps too few to

warrant the drawing of general conclusions, the following points may be mentioned:

1. In those places in which diphtheria had been and was widespread and where the enforcement of quarantine regulations had been lax, the percentage of infection of the school children with "typical" forms was greatest. This is shown in the examinations made at Albert Lea and Elbow Lake.

2. Where great care was taken in the isolation of clinical cases and the closing and later proper cleansing of the schools, the percentage of infection with "typical" forms was very small. This is ilustrated by the examinations made at Mankato.

3. At Faribault the percentage of infection with "typical" forms was greater than in the schools at Owatonna and Mankato. The time of year at which the examinations were made may have had something to do with this. The examinations at Faribault were made in March, after the children had been together at school for a number of months. At Owatonna, where the percentage of infection with "typical" forms was lowest, school had only been open for a few weeks, and a great deal of play, etc., could still take place out of doors. In Mankato the examinations were made in November, and, whilst it is true that diphtheria had occurred, those who were affected were kept in isolation until they were free of diphtheria and diphtheria-like bacilli. The schools had been closed and only reopened for a short time. It will thus be seen that when the first clinical cases occurred, the children had not been long enough at school to have effected a general exchange of the bacterial contents of noses and throats, and the closing of the schools facilitated the prevention of this exchange.

4. The percentage of infection with "atypical" forms alone is greatest in the school (Mankato) in which the percentage of infection with "typical" forms is lowest. The percentage with "atypical" forms alone is least in the school (Albert Lea) which showed the greatest percentage of infection with "typical" forms.

5. Had cultures been taken from the throats alone, the "typical" forms would have been found 11 times; whereas they are reported in 15 cases.

6. In these examinations infection of the throat with "typical" forms, the nose being free of all diphtheria-like bacilli, was more frequent (7 cases) than infection of the nose with "typical" forms when the throat was free of all diphtheria-like bacilli (3 cases). On the other hand, infection of the nose with "atypical" forms of B. diphtheriæ, the throat being free of all diphtheria-like bac-

teria, was more frequent (36 cases) than the converse condition in which the throats were infected only with "atypical" forms and the nose free of all diphtheria-like bacteria.

7. The number of persons showing both nose and throat infected with "typical" forms, whilst greater than the number of cases in which the nose alone was infected with "typical" forms (the ratio being 4:3) is less than the number of cases in which the throat alone was infected with the "typical" forms (7 cases).

8. The infection with "typical" forms in these examinations was therefore more frequent in the throat than in the nose, whilst the infection with "atypical" forms was more frequent in the nose than in the throat.

2. THE INHABITANTS OF INSTITUTIONS AND HOMES.

The State Public School for Dependent and Neglected Children was examined twice; once immediately after the supposed complete eradication of diphtheria and diphtheria-like forms from both nose and throat in March, 1899, and 66 of the children were examined eight months later (October). For a comparison of the two conditions see this Report, pages 519 and 521.

It has already been suggested that owing to the more frequent arrival of new inmates and the more frequent sending out of children to homes throughout the state, as well as to the fact that the older children attend the town public school, opportunities for infection are greater in this institution than in the State School for Feeble-Minded, in which the mental and other conditions necessitate a greater seclusion of the children and the education of the mentally fit at the institution itself. With these facts in mind, the higher percentage of infection with "typical" forms shown on both examinations at Owatonna is perhaps explained to some extent. In neither place had clinical diphtheria been reported for some months prior to the taking of the specimens.

Bethany Home may not be strictly comparable with the two other institutions, since clinical diphtheria, mild in two cases and fatal in one, was the reason for the first investigation. As no new cases had developed after five weeks, when the second examination was made, it may perhaps be more comparable to the examinations at the other institutions. The conditions in these institutions are so far from parallel that an accurate comparison is perhaps difficult. The opportunity for dissemination of diphtheria and diphtheria-like bacilli amongst the inhabitants was probably greater

in Owatonna and Bethany Home than in the School for the Feeble-Minded. The following points are shown by the table. Whether they would be constant or not cannot now be stated. Re-examination of these various places has been planned.*

1. The lowest percentage of infection with "typical" forms was shown to exist in the 50 examinations made at the State School for the Feeble-Minded. An examination of the whole institution might have shown a different state of affairs.

2. The highest percentage of infection with "typical" forms was found on the first examination made at Bethany Home. Next to this comes the second examination, which was only partial, of the State Public School for Dependent and Neglected Children.

3. The highest percentage of infection with "atypical" forms alone was found on the second examination of the State Public School for Dependent and Neglected Children and in the partial examination of the State School for Feeble-Minded (63 and 60 per cent).

4. The lowest percentage of infection with "atypical" forms alone was the second examination at Bethany Home.

5. The percentage of individuals free entirely of even suspicious forms was greatest in the second examination at Bethany Home, and least at the State Public School for Dependent and Neglected Children in the second (partial) examination.

6. The infection of the nose with "typical" forms is, amongst the inhabitants of the institutions, particularly marked, and especially so in Bethany Home. Of the total in all the institutions, 82 showed infection in the nose, whilst 54 showed infection in the throat. Fifty of these individuals (No. 3 of table) showed "typical" forms present in the nose, whilst the throat was free of all diphtheria-like bacilli. So that, if cultures had not been taken from the nose in these individuals, as well as from the noses of eight who showed the presence of "atypical" forms only in the throat whilst "typical" bacilli were present in the nose, there would have been 58 cases less which showed infection with the "typical" forms. This again accents the necessity of taking nose cultures. It is even more important from the point of view of determining infection with the "atypical" forms.

*Since this portion of the report went to press, re-examination of the Public School at Owatonna and of Bethany Home has been completed and will be reported in collaboration with the special committee appointed by the Association of Boards of Health of Massachusetts.

COMPARISON OF CHILDREN IN DAY SCHOOLS WITH THE INHABITANTS OF INSTITUTIONS AND HOMES.

A comparison of the condition of the noses and throats of the day school children with the inhabitants of the institutions, in these perhaps too few examinations, shows:

1. A higher percentage of infection with "atypical" forms alone in the day schools.

2. A higher percentage of infection with "typical" forms in the institutions.

3. The percentage of individuals free entirely from even suspicious forms is slightly higher in the institutions and homes than it was in the public day schools.

4. In the public day schools the ratio of the total percentage of throats infected to the total percentage of noses infected with "typical" forms was 8:5, whilst in the institutions the ratio was as 10:15.

It will therefore be seen that in the collection of cultures the possible error introduced by not taking synchronous nose cultures would have been far greater in the institutions than amongst the day school children.

In conclusion it may be remarked that the percentage of infection with "typical" forms is much greater in all investigations than had been anticipated. The earlier methods of recording, in which attempt was made to describe in words the forms of bacilli met with and their relative numbers, made it so difficult to tabulate satisfactorily that it was abandoned for the provisional classification which has been in use since October, 1899. It is, therefore, very difficult to compare the records for this whole period, 1899-1900. The use of the terms "typical" and "atypical" is very unsatisfactory, and, whereas, attempt has been made to classify under "typical" forms only those whose presence would be sufficient for the continuance of quarantine when found in specimens sent from clinical cases for laboratory report, it is perhaps possible that this may not have been done absolutely.

Whilst the records of these special investigations show a greater percentage of infection with "typical" forms than had been anticipated and than have been reported by other observers, it must be stated that the time of quarantine in this state, when it has been determined by laboratory findings, is not greater than in other states. This would indicate that in routine examinations in this laboratory it is not the custom to classify as diphtheria bacilli,

bacilli which would not be considered as "typical" in other laboratories. In the 208 cases which during 1899 and 1900 were examined and re-examined by the laboratory until all diphtheria-like bacilli had disappeared, the average period of persistence was under 25 days from the onset of symptoms. (See this Report, page 513.) Twenty-nine days from the first positive examination is the average time as determined by the laboratory in the city of Philadelphia.* The question then naturally arises as to whether the inhabitants of this state are more widely infected with B. diphtheriæ than is the case in other states. Perhaps the examination of the day school children, in most instances at a time when diphtheria was present in the town, does not give a fair idea of the condition of affairs. Examination of other districts in which no diphtheria has been known to exist for several years has been planned.

So far as the institutions are concerned, it is probable that conditions here are not different from those in other states where systematic investigations have not been undertaken. In two institutions in Rhode Island similar conditions to those in existence in this state have been found since publication of the earlier investigations of this laboratory (see page 601, this Report).

COLLABORATION WITH OTHER LABORATORIES IN THE INVESTIGATION OF THE DISTRIBUTION OF DIPHTHERIA AND DIPHTHERIA-LIKE BACILLI.

At the quarterly meeting of the Minnesota State Board of Health held Tuesday, April 11th, 1899, certain of the results of investigations made at Owatonna, Albert Lea, Elbow Lake, Faribault, etc., were presented. After giving the results of the investigations at that time completed, a plan for future work was submitted which involved:

1. The study of the diphtheria and diphtheria-like bacilli at that time isolated to determine:

   (a) Their reactions in all ordinary and special media.

   (b) Their pathogenesis for laboratory animals (immediate or by artificial increase of virulence).

   (c) If found virulent, to determine whether their toxins could be neutralized by diphtheria antitoxine.

   (d) To produce by repeated injections of their toxins a serum to be tested as to its capacity for neutralizing toxin from

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*Abbott—Hygiene of Transmissible Diseases, Philadelphia, 1899, p. 117.

virulent diphtheria cultures (obtained from clinical cases of diphtheria).

2. To obtain as much information as possible regarding the history of the children in whom diphtheria-like bacilli were found.

3. As opportunity offered it seemed imperative:

(a) To obtain cultures from the same sources as frequently as possible under varying conditions.

(b) To obtain cultures from other city and country districts both where diphtheria had been recently prevalent, and if possible where no cases had occurred for a long time.

(c) To obtain cultures from all parts of the state where people are housed together in large numbers for a considerable time.

4. When tabulation of results already obtained had been completed, and as soon as a just estimate could be placed upon them, it was proposed to put them into the form of a short printed circular letter to be addressed to other laboratories throughout this country and Europe, with a request for information as to what had been the experience of each in this regard.

The permission of the Board was asked for and granted at this meeting. (See minutes, page 7.)

The work as planned, particularly owing to the difficulties of tabulation of results obtained, was so great that the circular was not prepared at the time.

The studies of the bacteria isolated from the various sources were continued in the laboratory and partially reported (see this Report, page 586). Attention was chiefly concentrated upon the formulation of an accurate plan of classification whereby the results of investigations by this laboratory could be compared accurately, first with each other and secondly with those obtained by other laboratories.

After the presentation of the first rough draft of the provisional classification, and before its final completion (see page 613, this Report), the Association of Boards of Health of Massachusetts appointed a committee on "Diphtheria Bacilli in Well People." This committee issued a circular which was forwarded to various laboratories and boards of health throughout this continent and Europe. The following is a list of the questions therein asked:

1. Have you established an organized system for the bacteriological examination of cases of suspected diphtheria?

2. What number of cases examined for diagnosis show a negative culture on the first examination and a positive culture on a subsequent examination? (Give exact figures if possible.)

3. What do you require for the release from isolation of diphtheria patients?

(a) Time limit after disappearance of membrane? If so, how long?

(b) Judgment of attending physician that danger of infection is past?

(c) One negative culture
From throat only?
From throat and nose?

(d) Two negative cultures
From throat only?
From throat and nose?

(e) Any other method?

4. Do you examine bacteriologically as a routine practice the throats and noses, or both, of those who may be in contact with cases of diphtheria?

5. When cultures from diagnoses are taken separately from both nose and throat of sick persons, what proportion of the cases so treated give the following results? (Give actual figures.)

(a) Total number of sick persons thus examined?

(b) Total number showing throat positive and nose positive?

(c) Total number showing throat positive and nose negative?

(d) Total number showing throat negative and nose positive?

(e) Total number showing throat negative and nose negative?

6. When cultures are taken separately from both nose and throat of well persons exposed to diphtheria, what proportion of the cases so tested show the following results?

(a) Total number of well persons thus examined?

(b) Total number showing throat positive and nose positive?

(c) Total number showing throat positive and nose negative?

(d) Total number showing throat negative and nose positive?

(e) Total number showing throat negative and nose negative?

7. When cultures are taken separately from both nose and throat of well persons not exposed to diphtheria so far as known, what proportion of the cases thus tested show the following results?

(a) Total number of well persons thus examined?

(b) Total number showing throat positive and nose positive?

(c) Total number showing throat positive and nose negative?

(d) Total number showing throat negative and nose positive?

(e) Total number showing throat negative and nose negative?

8. What proportion of those exposed take the disease in your experience? (Give actual figures.)

9. What proportion of those exposed, who show also the diphtheria bacilli in their throats or noses, subsequently and within a short time develop the disease? (Give actual figures.)

10. Do you make any difference in your management of the classes of cases mentioned below? Which do you officially designate as diphtheria and which do you placard and isolate?

(a) A person showing membrane and diphtheria bacilli present?

(b) A person showing the lesions of follicular tonsilitis and diphtheria bacilli present, but no history of exposure?

(c) A person showing the lesions of follicular tonsilitis and diphtheria bacilli present, with history of exposure?

(d) A person showing inflammation of the throat, without membrane or exudate, and diphtheria bacilli present, but no history of exposure?

(e) A person showing inflammation of the throat, without membrane or exudate, and diphtheria bacilli present, with history of exposure?

(f) A person quite well in every respect and diphtheria bacilli present, but no history of exposure?

(g) A person quite well in every respect but diphtheria bacilli present, with history of exposure?

(h) A person showing a typical membrane, but diphtheria bacilli absent after repeated examinations, and other organisms not present in kind and number to account for lesions?

(i) A person showing typical membrane, but diphtheria bacilli absent after repeated examinations, and streptococci prominent in culture?

11. Do you test the virulence of diphtheria bacilli in doubtful cases for diagnosis?

12. Do you test the virulence of diphtheria bacilli persisting in the throat of a recovered diphtheria patient? In what proportion of cases is this done? (Please give actual figures.)

13. What is your exact method for testing virulence?

14. Have you attempted to classify the different types of diphtheria bacilli by the method of the Minnesota State Board of Health Bacteriological Laboratory?

15. If so, do you find any relation between the type of diphtheria bacilli found and their virulence?

16. What relation have you found, or have you any evidence to show that a relation exists, between the morphology of the diphtheria bacillus and the composition, reaction, age, moisture, etc., of the serum employed as a culture medium?

17. Have you any evidence that the bacilli gradually lose virulence during the recovery of a case of diphtheria?

18. If tests for virulence are made, do you maintain isolation on the strength of the virulence found or terminate it if the bacilli are not virulent?

19. Give particulars of cases in your own experience where well persons having diphtheria bacilli in their throats or noses have communicated the disease to others? (Please state whether these well persons were convalescents or had not had diphtheria themselves.)

20. If diphtheria breaks out in an institution (asylum, jail, school, reformatory, hospital, etc.), what is your procedure to control and get rid of the epidemic?

(a) Do you take cultures from all inmates present at the time of the outbreak, or only from those exposed?

(b) Do you take cultures from all persons admitted to the institution during the course of the epidemic?

(c) Do you isolate all those showing positive cultures in the absence of lesions or only those with suspicious throats? (Please state in a, b and c if cultures are taken from throat only, or from both throat and nose.)

(f) How do you determine when it is safe to allow those exposed or infected to mingle with the uninfected inmates again?

(g) What precautions, other than bacteriological examinations of nose and throat and isolation of those showing positive cultures, do you consider necessary?

A complete tabulation of the replies received has not yet been published, but is expected to appear shortly.

The next step of the committee appointed by the Massachusetts Association of Boards of Health on "Diphtheria Bacilli in

Well People" was to ask the collaboration of various laboratories throughout the country who were in a position to make a study of the distribution of diphtheria and diphtheria-like bacilli in the throats and noses of the apparently healthy. The committee asked the collaboration of this laboratory, and adopted the classification of the types of diphtheria bacilli originated in and published from this laboratory. Work is now in progress throughout this continent by which it is hoped to obtain an accurate idea of the distribution of diphtheria and diphtheria-like bacilli in the noses and throats of ten thousand individuals. Each laboratory collaborating will endeavor to obtain specimens for examination from individuals whose conditions are, so far as possible, parallel. The draft for the record blanks for the results of examinations by all collaborators was furnished by this laboratory. The following is a reproduction of the record blank:

RECORD BLANK.

Indicate here the types of B. diphtheriæ found and the relative numbers of individuals of each type by placing numerals in the columns, thus:—The most prominent type will be marked 1, the next most numerous 2, and so on. Leaving the columns blank where no corresponding type is found.

Examination Number	Name or other means of identification in case a second specimen were desirable, etc.	Age	Sex	Date	Time Between Taking of specimen and Placing it in the Incubator	Time of Incubation	Age of Serum	Age of Loeffler's Methylen Blue	NOSE CULTURES.																													
									DIPHTHERIA-LIKE BACILLI																					OTHER BACTERIAL FORMS								
									Granular Types							Barred Types							Solid Types															
									A	B	C	D	E	F	G	A^1	B^1	C^1	D^1	E^1	? F^1	? G^1	A^2	B^2	C^2	D^2	E^2	F^2	G^2	Staphylococci	Streptococci	Diplococci	Bacilli not B. diphtheriæ	Sarcinæ	Yeasts	Moulds	Spirilla	Remarks

Indicate here the types of B. diphtheriæ found and the relative numbers of individuals of each type by placing numerals in the columns, thus:—The most prominent type will be marked 1, the next most numerous 2, and so on. Leave the columns blank where no corresponding type is found.

Here put in details about kind of school or institution, character of life, etc., etc. Should the incubator go wrong, specimens be unsatisfactory, etc., etc., etc., etc., etc., note it here.

THROAT CULTURES.																														Indicate Here by Plus or Minus Signs the the Virulence of the Bacilli Tested, and the Particular Type Isolated for the Test by its Corresponding Letter	What Report Would You Furnish Had the Case Examined Been a Convalescent Clinical Case	REMARKS.
DIPHTHERIA-LIKE BACILLI																					OTHER BACTERIAL FORMS											
Granular Types							Barred Types							Solid Types																		
A	B	C	D	E	F	G	A^1	B^1	C^1	D^1	E^1	?F^1	?G^1	A^2	B^2	C^2	D^2	E^2	F^2	G^2	Staphylococci	Streptococci	Diplococci	Bacilli not B. diphtheriæ	Sarcinæ	Yeasts	Moulds	Spirilla	Remarks			

When these results are tabulated, it is hoped that our knowledge of the distribution of diphtheria and diphtheria-like bacilli in well people may be more complete.

No complete study of the distribution of the various types of diphtheria and diphtheria-like bacilli in the throats and noses of clinical cases has hitherto appeared. Collaboration with other laboratories in the tabulation of the results obtained in the examination of routine specimens from clinical cases, in accordance with this same classification, has been contemplated by this laboratory for a long time. Other laboratory men, to whom the matter has been broached, have signified their willingness to undertake such collaboration. It would seem that without a knowledge of the various types of diphtheria and diphtheria-like bacilli, which are to be met with in clinical cases, any record of the types of bacilli met with in the throats of well people will be very much less valuable.

The demands made by other work have rendered it impossible to undertake this work as yet. Since November, 1899, all routine examinations made in this laboratory have been recorded in the terms of the classification. One hundred of the examinations made in which the forms of diphtheria and diphtheria-like bacilli were classified have already been published (see page 631, this Report). It seemed best to tabulate and record permanently all the results of examinations of clinical cases for 1900 as well before asking the collaboration of other laboratories along certain definite lines. In other words, it was felt that the tabulation of the records of the routine examinations of specimens from clinical cases made during 1900 in this laboratory might alter to some extent the lines along which it seemed desirable to operate. (For such tabulation of clinical cases examined during 1899 and 1900 see this Report, p. 636 et seq.)

A CASE OF SUSPECTED RABIES WITH ISOLATION OF BACILLUS DIPHTHERIÆ FROM THE CENTRAL NERVOUS SYSTEM.*

BY GEORGE DOUGLAS HEAD, M. D., AND LOUIS BLANCHARD WILSON, M. D.

(University of Minnesota.)

CLINICAL REPORT.

BY GEORGE DOUGLAS HEAD, M. D.

On the morning of Sept. 28, 1897, Mrs. L. R. presented herself for the surgical treatment of a bite of the left cheek. She stated that about 4 o'clock that morning she was awakened by a noise in the chicken coop, and, hurrying on her clothing, went out to investigate. As she pushed open the door of the coop an animal sprang out upon her, biting her on the left cheek. The wound bled profusely, and to stop the hemorrhage she applied some liniment and a bandage.

When she presented herself for treatment, five hours after the accident, there were two sharp, deep punctures on the left cheek, one-half inch apart, sinking deeply into the underlying tissue, from which, on pressure, a bloody grumous fluid exuded. The wound was scrubbed with soap and water, washed out with peroxide of hydrogen and packed with gauze. Two days following, the same treatment was repeated. At the third dressing, as the wound seemed clean, it was allowed to granulate over, and the patient was dismissed.

Nothing more was heard of the patient until Dec. 3d, two months and five days following the bite. On that day the patient again came, complaining of severe pain and numbness over the left cheek in the region of the previous bite. The office notes were as follows:

Woman, thirty-two years, well nourished, married, two children, one miscarriage, mother and father and one sister living; mother well; father has ill health, of which the cause was not ascertained; previous history uneventful. Had neuralgia of right side of face

*The work embodied in this paper was completed before the publication of the last biennial report of this board. The paper had not then, however, appeared in the Journal of Experimental Medicine. Vol. iv., Nos. 3 and 4, 1899.

some years ago. No other ailments. No history of hysteria or other neuroses.

The pain of which the patient complains is localized on the left cheek in the region of the scar of the previous bite. It commenced two days ago as a mild aching and numbness in that region and has been gradually growing more severe. There is little swelling and only slight tenderness on pressure over the area of pain. There is complaint of some difficulty in opening the mouth owing to pain in the temporo-maxillary articulation. Patient complains of loss of sleep. Temperature 98.8° F. Pulse 100.

Diagnosis: facial neuralgia. Treatment: phenacetine and salicylates.

Dec. 4. Patient at office. Tenderness most marked over the site of the bite. Pain paroxysmal in character, running along the ramus of lower jaw, up the side of head, in front and back of left ear, and back along the left sternocleidomastoid muscle. As patient complains of difficulty in swallowing, I give her a glass of water to drink. She raises the glass to her lips, gives a short, jerky inspiration and swallows the liquid. Suspecting rabies, I call Dr. Hunter in consultation.

Patient carefully examined. No throat lesions. No decayed teeth. No ear trouble. Tenderness sharply localized over the area supplied by middle branch of fifth nerve. Temp. 99.4°. Diagnosis: neuralgia of middle branch of fifth nerve or beginning rabies. Treatment: morphine.

December 5. Fifth day of disease. Called at 4 a. m. Patient has spent a bad night, with little sleep. Excruciating pain over same area, as described. Mouth opened with more difficulty. Can swallow saliva, but if she attempts to drink water, tea or milk she takes a number of short, quick, catchy inspirations, her eyes start from her head, she looks wildly about, then swallows the fluid with a gulp. The swallowing seems a great effort and tires her. Temperature 99°. Pulse 108. Heart, lungs and abdomen normal. No enlarged spleen. Bowels constipated. Urine, acid, 1024. No albumen or sugar. Urea 2.5 per cent. No casts, blood or leucocytes. Diagnosis: suspected rabies.

December 5, 4 p. m. Patient resting easier. Laryngeal and respiratory spasms more pronounced. Now even the taking of a glass of fluid into her hand causes a faint spasm. As she puts the liquid to her lips her hand will shake violently, the catchy inspirations will begin, and it seems almost impossible for her to swallow. She can swallow solids, though with some difficulty. With the excep-

tion of the laryngeal spasms and the pain, she seems perfectly normal. Sits up in a chair, talks with her friends, and is undisturbed mentally. Temperature 99.2°. Pulse 110, irregular and rapid. Respirations normal.

December 6, 8 a. m. Drs. Hunter and Sweeney in consultation. Sleepless night. Has taken little nourishment and no fluids. Complains much of thirst. Bowels moved. Temperature 100°. Pulse 110. Respiratory and laryngeal spasms on taking fluids. Application of snow to face or arm causes the spasms. Pupils react to light and accommodation. Reflexes feebly present. Knee-jerk absent in right leg, present in left leg. No ankle-clonus. No areas of hyperæsthesia. On left tonsil white exudate, which is removed with swab, supposed to be due to a strong solution of sulphuric acid used by her mother for swabbing out the throat. Heart, lungs and abdomen normal. Treatment: morphine; fluid enemata.

December 6, 4 p. m. No change. Slept some after the morphia. Laryngeal and respiratory spasms present on taking liquids; also, in less pronounced degree, on taking solids. Complains bitterly of thirst, but can scarcely be induced to attempt to drink. Temperature 101°. Pulse 108. Respiration normal. Cocainized pharynx and gave one pint of milk by stomach-tube.

December 6, 12 p. m. Pain in face not complained of. Laryngeal and respiratory spasms manifested as before. Temperature 101°. Pulse 110. Gave one pint of milk by stomach-tube; also morphia.

December 7, 9 a. m. Dr. Jones in consultation. Patient seems brighter and more cheerful. Slept some during the night. Can swallow oysters and crackers moistened in water. On offering her some milk to drink she pleads not to be asked to try, but finally takes a swallow, only to exhibit the same laryngeal and respiratory spasms in a more pronounced degree. Now as she attempts to take fluid her eyes bulge, she clutches a support to sustain herself, her whole body seems in a violent tremble, and as the fluid touches her lips there comes a series of quick respirations, followed by a convulsive cough, which blows the milk out of her mouth over herself and the bed clothes. Temperature 100.5°. Pulse 120. Bowels moved. Gave one pint of milk by stomach tube; also bromides.

December 7, 5 p. m. Temperature 101.5°. Pulse 120. Tongue coated white, pharynx normal. Eyes bright. Mind clear. No sleep. Treatment: morphia. Milk and water by stomach tube.

December 7, 12 p. m. Patient seems languid and tired. Wants

to sleep but cannot. Face flushed, eyes bright. Laryngeal and respiratory spasms easily produced. Temperature 102°. Pulse 130. No rose spots. No tympanites. No enlarged spleen. Heart and lungs normal. Give eggs and one pint of milk by stomach tube; also morphia to induce sleep.

December 8, 8 a. m. Dr. Hunter in consultation. Patient passed a good night. Laryngeal and respiratory spasms present. Knee-jerk absent. Pupils react to light and accommodation. No ankle-clonus. Superficial reflexes normal. No rose spots. No enlarged spleen, nor tympanites. Temperature 103.2°. Pulse 130. Take blood for Widal test. Give two eggs, milk and whiskey by stomach tube. No morphia.

December 8, 4 p. m. Patient complains of pain in upper abdomen, extending around the body. Stomach distended with gas. Temperature 102.8°. Pulse 120. Blood examination: leucocytes, 6,000; red corpuscles, 5,500,000. Hæmoglobin, 90 per cent. Widal test (State Board of Health Laboratory) gives a positive typhoid reaction (see p. 563). Give two eggs, milk and whiskey by stomach tube.

December 8, 8 p. m. Patient seems better. Complains of pain in limbs and back. Mind clear. Laryngeal and respiratory spasms present. Temperature 102.5°. Pulse 120. Tongue coated white. No morphia.

December 9, 8 a. m. Patient complains of pain in abdomen, which is relieved when bowels move. Laryngeal and respiratory spasms still severe. Lungs and heart normal. No rose spots. No tympanites. No enlarged spleen. Urine 1024, acid, a trace of albumin, no sugar, urea 3 per cent. No casts, leucocytes or blood corpuscles. Temperature 102.2°. Pulse 120. Ate six oysters and took a few swallows of milk.

December 9, 8 p. m. Patient slept some during the day. Laryngeal and respiratory spasms not so pronounced. Temperature 103.2°. Pulse 120. Knee-jerk absent. No ankle-clonus. Sensation normal. Grasp of right and left hand unimpaired. Pupils react to light and accommodation. Patient drinks a cup of milk. No morphia.

December 10, 8 a. m. Patient delirious, with rational intervals. No sleep during the night. Had hallucinations of being drowned, of the house on fire, of persecution. Occasionally patient had a general tremor of the whole body. Temperature 102°. Pulse 110; irregular. Had eaten some bread and milk.

December 10, 8 p. m. Patient extremely nervous. Fingers

twitch. Casts furtive glances this way and that. Low, incoherent muttering. Temperature 101°. Pulse 130. Passes urine and bowels move. Has taken milk and broth.

December 11, 3 a. m. Called in haste. Patient in violent delirium. Had gotten out of bed, knocked down nurse and run out of doors. Patient tries to tear her clothing, bites at those about her. Has to be held by force. Quieted by one-half grain of morphia. Temperature 103°. Pulse 120. Urine 1022; large amount of albumin; no sugar; urea 4 per cent; a few pus cells, with a few hyaline casts and cylindroids.

December 11, 8 a. m. Dr. Hunter in consultation. Patient perfectly rational. Recognizes those about her. Talks sensibly, but there are occasional twitchings about the eyes. Quick glances this way and that. Takes little nourishment. Temperature 102.2°. Pulse 110. Calomel administered to move the bowels.

December 11, 8 p. m. Patient seems worse. Muttering delirium. Constant twitching of muscles of whole body. Eyes bright, face red and injected. Tongue flabby, with pasty coat. Passes urine and bowels move. Temperature 104°. Pulse 110. Treatment: morphia ($\frac{1}{2}$ gr.), whiskey and strychnia.

December 12, 10 a. m. Patient does not recognize me. Seems more quiet, inclined to lie still. Has taken three or four cups of water and some milk. She drinks now without the occurrence of spasms. Severe attacks of trembling of whole body or of one limb, then another. Urine 1028. Large amount of albumin, a few hyaline casts. Temperature 102.2°. Pulse 140. Treatment: whiskey and strychnia.

December 12, 8 p. m. Dr. Sweeney in consultation. Patient worse. Has hoarse cough, rapid respirations. There is an increased flow of saliva from mouth. Muttering delirium; picking at bedclothes; violent shaking of limbs. Heart normal. Lungs, fine, mucous rales at bases. Abdomen normal. Take blood for Widal test.

December 13, 8 p. m. Thirteenth day of disease. Patient has had no sleep; speech thick and incoherent. Can be aroused, but if left alone lies in a semi-conscious state. Temperature 102°. Pulse 130. Blood examination: red corpuscles, 5,120,000; leucocytes, 14,500.

Widal test (State Board of Health Laboratory) gives a positive typhoid reaction (p. 457). Notwithstanding this report there is little clinical evidence of typhoid fever. The leucocyte count in the

second week of uncomplicated typhoid would not be increased. Typhoid fever is, therefore, not the probable diagnosis.

The laryngeal and respiratory spasms are again produced by the swallowing of solids or liquids or the putting of one's hands on the body or wiping away mucous from the mouth.

December 13, 8 p. m. Patient is unconscious. Has taken no nourishment. Short, sharp muscular contractions sweep over the arms and legs. Temperature 102°. Pulse 140. Respirations feeble and superficial. There is an occasional mucous rattle in the trachea. It does not seem possible that the patient can long survive.

December 14. Patient died at 5 a. m. in an unconscious state, the respirations being previously rapid and superficial and the heart's action irregular.

Autopsy, sixteen hours after death, the body having been kept at low temperature. A complete examination was not permitted.

Body well nourished. Rigor mortis pronounced. Scar on left cheek. Patchy livores mortis over posterior surface of body.

Dura adherent along superior logitudinal sinus. No other adhesions. Slight hyperæmia of dura, which it not thickened. Pia somewhat hyperæmic, free from exudate.

An incision was made with sterilized scalpels into left lateral ventricle and 1 cc. of clear serum was removed in a sterilized pipette, the end of the pipette being immediately sealed in a flame.

Cerebral convolutions well developed and normal. No exudate or effusion. No adhesions. No areas of softening. Vessels somewhat injected. Punctate oozing on section of brain. Meningeal vessels normal. No tubercles, emboli, thrombi or adhesions. Cerebellum normal. Basal ganglia normal.

The third ventricle was opened with a sterile knife, and by means of sterile pipette some bloody fluid was withdrawn, the ends of the pipette being at once sealed in a flame.

The medulla and pons Varolii were removed with sterilized instruments and placed in a sterilized flask.

A complete post-mortem examination not being allowed, the abdominal cavity was opened by a median incision only 10 cm. long. There were no adhesions or increase of fluid in the peritoneal cavity. The peritoneum and the intestines, both small and large, showed no abnormality. Parts of the cæcum and ileum were removed. Peyer's patches and the solitary follicles were not affected.

The right kidney was somewhat enlarged and congested. Capsule stripped off with ease. Dard red areas were scattered over the cortex. The left kidney presented the same appearance. Pieces of kidney removed and placed in 95 per cent alcohol. Liver appeared normal. Spleen was not enlarged. All tissues and fluids taken at the autopsy were kept on ice until taken to the State Board of Health Laboratory thirteen hours later.

PATHOLOGICAL AND BACTERIOLOGICAL REPORT.

BY LOUIS BLANCHARD WILSON, M. D.

(From the Bacteriological Laboratory of the Minnesota State Board of Health.)

The connection of the laboratory with the case, of which the clinical history has been given by Dr. Head, began with the receipt, on Dec. 8, 1897, of a specimen of blood for examination for the serum reaction for typhoid fever. The specimen was dried on a visiting card, and consequently only a colorimetric estimate of the dilution employed could be made. The reaction was present in a dilution of 1:25, so estimated. On Dec. 13, another specimen, collected, weighed and accurately diluted after the author's method,* was found to give a good reaction in a dilution of 1:25, partial in 1:50, and a trace in 1:100.† In consequence of these two reactions special care was taken in the bacteriological examination of the specimens secured at the autopsy.

On December 15, at 9 a. m., there were received at the laboratory one sealed bulb, containing about 1 cc. of fluid from the left lateral ventricle of the brain; a similar bulb, with about 0.5 cc. of fluid from the third ventricle; the lower two-thirds of the medulla, with about 1 cm. of the cervical cord, in a sterile flask plugged with cotton wool, and about 2ccm. of the pons, which had been placed in 4 per cent formaldehyde solution at the autopsy, and a portion of one kidney wrapped in gauze. Later there was also received another portion of the kidney, which had been placed in 80 per cent alcohol at the time of the autopsy.

Coverslip preparations. Four coverslip preparations each were made from the fluid from the left ventricle, from that from the

*Wesbrook and Wilson, *Philadelphia Med. Journ.*, 1898, i, 549.

†These reactions are perhaps explicable on either of two hypotheses: *(a)* a typhoid infection existed, and other pathological evidence of it was not obtained, owing to tne incomplete autopsy permitted; *(b)* though no history of a previous typhoid fever was elicited, the exclusion of a previous typhoid infection would seem to be almost impossible, since the patient had been for years a resident of a city in which for a decade typhoid fever has been endemic, and from the public water-supply of which the typhoid bacillus was isolated a year ago. (See Wilson and Wesbrook, *British Med. Journ.*, 1897, ii, 1774.)

third ventricle, from the substance of the medulla and from that of the kidney. They were stained with methylene-blue and eosine. Those from the lateral ventricle showed very few cocci, and two or three bacilli rather unevenly stained. In those from the medulla were found a few isolated cocci. No bacteria were found in any of the others.

Sections.—Kidney. In a portion of kidney placed in alcohol at the autopsy, many of the glomeruli were apparently normal. A few showed more or less complete hyaline degeneration and some cloudy swelling, with disappearance of the nuclei of the epithelium of the convoluted tubules. No bacteria could, with certainty, be distinguished.

Nerve tissues. Portions of tissue from the pons, medulla and cord were fixed and hardened in 96 per cent alcohol, embedded in celloidin and in paraffine, and sections 3, 5, 10 and 20 microns in thickness cut therefrom. These were stained by Nissl's method, by Weigert-Gram and by Löffler's methylene-blue alone. The walls of some of the vessels were thickened. Where this occurred, the vessels were filled with blood and the walls infiltrated with leucocytes. In some instances the perivascular spaces were completely filled with leucocytes. No accurate determination of the condition of the nerve fibres could be made by the methods employed. With Nissl's stain, many of the cells of the grey matter of each of the regions studied appeared to be perfectly normal. A large number of these cells, however, showed chromatolysis in varying degrees, from simple irregularity and subdivision of the Nissl granules to the almost complete disappearance of the chromatin. In most instances the periphery of the cell-body was least affected. Where chromatolysis was at all marked the nucleus and nucleolus were, in most cases, eccentrically placed. In a few instances the nucleus was distorted in shape; in others enlarged, irregularly crescentic nucleoli were present. Apparent complete absence of processes from some of the most affected cells was noted.

The foregoing changes were common to pons, medulla and cord. In addition, in the medulla and cord—which had been thirteen hours longer out of preserving fluid—were found occasional cells, in which the nucleoli, while not enlarged, were partially divided, the nuclei stained light blue throughout and the cell-body was filled with well stained, finely divided granules, the otherwise even distribution of which was broken up by "vacuoles." The writer,

however, agrees with Ewing[1] and others in considering these cadaveric rather than vital changes.

In the sections of the pons and medulla stained by Weigert-Gram and by Löffler's methylene-blue, several groups of bacilli were found. These, in size, shape and staining characteristics, could not be distinguished from *Bacillus diphtheriae*, and, in view of the cultural findings to be described later, in all probability were such. The groups consisted of two to five individuals each and were located within the bodies of the larger nerve cells. They were not observed in the vessels or perivascular spaces.

Though many observers, among others Löffler,[2] Kolisko and Paltauf,[3] Strelitz,[4] Johnston,[5] Abbott and Ghriskey,[6] Flexner,[7] Frosch,[8] Booker,[9] Canon,[10] Kutscher,[11] Wright and Stokes,[12] Belfanti,[13] Kanthack and Stephens,[14] and Flexner and Anderson,[15] (the last two papers contain good reviews of the previous literature), have demonstrated the presence of B. diphtheriæ in the internal organs of patients dead of clinical diphtheria, or similarly in animals dead from experimental inoculation, yet, so far as I am aware, Frosch alone has hitherto shown their presence within the central nervous system.

Cultures. Tubes of plain bouillon, glycerine agar and glycerine serum were sown direct from the bulb of ventricular fluid, from the substance of the central portion of the medulla, and from the kidney. The latter was then wrapped in 1:1000 bichloride gauze, incubated for twenty-four hours and second cultures were made.

Of four tubes of solid media inoculated from the right ventricle one—serum—developed three colonies of a bacillus indistinguishable in cover-slip preparations from B. diphtheriæ—and shown later to be such—and one colony of a diplococcus. Another—agar—developed one colony of a diplococcus. The broth cultures gave both B. diphtheriæ and diplococci. Four tubes from

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1 Ewing, J., *N. Y. Med. Record*, 1898, liii, 513.
2 Loeffler, *Mittheil. a. d. k. Gesundheitsamte*, 1884, ii, 421.
3 Kolisko and Paltauf, *Wiener klin. Wochenschr.*, 1889, ii, 147.
4 Strelitz, *Archiv f. Kinderheilk.*, 1891, xiii, 468.
5 Johnston, *Montreal Med. Journ.*, 1891, xx, 161.
6 Abbott and Ghriskey, *Bulletin of the Johns Hopkins Hospital*, 1893, iv, 29.
7 Flexner, Ibid, iv., 32.
8 Frosch, *Zeitschr. f. Hyg.*, 1893, xiii, 49.
9 Booker, *Arch.of Pediatrics*, 1893, x, 642.
10 Canon, *Deutsche med. Wochenschr.*, 1893, p. 1038.
11 Kutscher, *Zeitschr. f. Hyg.*, 1894, xviii, 167.
12 Wright, *Boston Med. and Surg. Journ.*, 1894, cxxxi, 329; 357.
12 Wright and Stokes, Ibid., 1895, cxxxii, 271; 293; 330. Stokes, ibid, 1895, cxxxiii, 581.
13 Belfanti, *Lo Sperimentale, Sez. biol.*, 1895, xlix, 278.
14 Kanthack and Stephens, *Journ. of Path. and Bact.*, 1896-7, iv, 45.
15 Flexner and Anderson, *Bulletin of the Johns Hopkins Hospital*, 1898, ix, 72.

the third ventricle gave two to ten colonies each (broth abundant growth), about two-thirds of which were B. diphtheriæ and the remainder streptococci and diplococci.

Though the sowing from the medullary substance were abundant, only two of seven tubes showed growth. One of these—agar—gave one colony of diplococci and the other—broth—many B. diphtheriæ and diplococci.

From the kidneys a few colonies of a large white staphylococcus and an abundant growth of B. coli communis developed.

The diphtheria-like bacillus was isolated and carefully compared with specimens of known virulent diphtheria bacilli. Parallel cultures were made on Löffler's and glycerine serum, on plain, glycerine and litmus-lactose agar, on plain and glucose gelatin, on potato, in plain, glycerine, glucose and sugar-free bouillon, and in plain and litmus milk. The cultures were compared as to rate and character of growth, reaction of the media and appearance of stained preparations. In no particular did the organism under investigation differ materially from those with which it was compared. In the earlier cutures—on glycerine serum—it produced involution forms (large clubbed and "ghost" forms) somewhat more quickly than the controls, but this property was lost by the time the tenth generation was reached.

Animal inoculations with cultures. In order to determine the virulence and identity of the bacillus, guinea pigs were inoculated, with the results shown in Table I.

TABLE NO. 22.

GUINEA-PIG INOCULATIONS WITH BACILLUS X.

No.	W'ght.	Subcutaneous inoculation in right groin.	Protected (?) by subcutaneous injection in left groin of	Period from inoculation till death.	Positive gross findings at autopsy.	Glycerine serum and bouillon cultures made at the autopsy: examined after 24 and 48 hours in the incubator.
	Grms.					
1	520	0.5 cc. 40-hour plain bouillon culture of Bacillus X.	Not protected.	4 days.	Intense œdema at seat of inoculation. Liver slightly enlarged. Meninges slightly congested.	Seat of inoculation = Bacillus X pure. Heart's blood = sterile. Spleen = sterile. Ventricles and substance of brain and spinal cord = sterile.
2	450	Same dose and culture as with No. 1	Not protected.	4 days.	Intense œdema at seat of inoculation. General œdema over whole ventral portion of body.	Same as in No. 1.
3	390	"	60 units, N. Y. City B'd of Health diphtheria antitoxine.	40 days.	Small area of extravasation at seat of inoculation. Animal much emaciated.	All cultures sterile.
4	330	"	30 units of the same.	32 days.	Animal much emaciated.	All cultures sterile.
5	430	0.43 cc. 40-hr. sugar-free bouillon culture of Bacillus X.	Not protected.	2 days.	Intense congestion and œdema at seat of inoculation. Spleen enlarged, congested.	Same as in No. 1.
6	410	0.41 cc. of same culture as in No. 5.	Not protected.	2½ days.	Same as No. 5, and, in addition, kidneys much congested.	Same as in No. 1.
7	250	0.25 cc. of same culture as in No. 5.	Not protected.	2 days.	Same as No. 5, and in addition, liver much congested.	Same as in No. 1.
8	410	0.41 cc. of same culture as in No. 5.	50 units, Parke, Davis & Co.'s antidiphtheritic serum. (Mixed with bacteria immediately before their injection into right groin.)	38 days.	Area of slight infiltration at seat of inoculation. Three abscesses in liver. Subcapsular abscess on surface of right kidney. Spleen pale.	Seat of inoculation, heart's blood spleen and brain substance = sterile. Liver abscess, Kidney abscess, } { Short, thick bacilli, not diphtheria.
9	160	0.16 cc. 70-hr. plain buillon culture of bacillus X.	Not protected.	2 days.	Much œdema at seat of inoculation. Kidneys pale. Spleen much congested.	Same as in No. 1.
10	600	0.6 cc. of same culture as in No. 9.	Not protected.	3 days.	Same as in No. 9, and, in addition, adrenals and liver congested.	Same as in No. 1.
11	275	0.275 cc. of same culture as in No. 9.	150 units, P., D. & Co.'s anti-diphtheritic serum.	14 days.*	Lungs fill thoracic cavity, in state of congestion. Kidneys slightly softened.	Heart's blood = staphylococci. Seat of inoculation, spleen and brain substance = sterile.
12	250	0.5 cc. of same culture as in No. 9.	150 units of same.	18 days.*	As in No. 11.	As in No. 11.

* These 2 guinnea-pigs were from a lot of 50 received but a few days before, and all the others o which died of pneumonia (?) in periods of from 1 to 3 weeks after their receipt in the laboratory.

TABLE NO. 23.

GUINEA-PIG INOCULATIONS WITH TOXINE FROM BACILLUS X.

No.	W'ght.	Subcutaneous inoculation in right groin.	Protected (?) by	Period from inoculation till death.	Positive gross findings at autopsy.	Glycerine, serum and bouillon cultures made at autopsy and examined after 24 and 48 hours in the incubator.
13	300	0.15 cc. filtered toxine—prepared by growing Bacillus X 23 days in the incubator in sugar-free bouillon.	Not protected.	3½ days.	Much œdema at seat of inoculation. Spleen enlarged and congested. Liver enlarged and congested.	Seat of inoculation, Spleen, Heart's blood, Ventricles and substance of brain and spinal cord. }—sterile.
14	310	0.31 cc. of same material as in No. 13.	Not protected.	1½ days.	Same as in No. 13.	Same as in No. 13.
15	330	0.15 cc. of same material as in No. 13.	0.3 cc. serum of Rabbit No. 1. (Normal—afterwards immunized with toxine noted in G. P. 13) Serum mixed with toxine immediately before inoculation.	3½ days.	Same as in No. 13.	Same as in No. 13.

TABLE NO. 24.

GUINEA-PIGS PROTECTED WITH ANTITOXIC SERUM PREPARED WITH BACILLUS X.

No.	W'ght.	Subcutaneous inoculation in right groin.	Protected (?) by subcutaneous injection of	Period from inoculation till death.	Positive gross findings at autopsy.	Glycerine serum and bouillon cultures made at the autopsy; examined after 24 and 48 hours in the incubator.
	Grms.					
16	400	0.25 cc. 31-day sugar-free broth culture of known B. diphtheriæ (series De C).	Not protected.	1½ days.	Intense œdema and consestion at seat of inoculation. Spleen congested.	Seat of inoculation—B. diphtheriæ, pure. Heart's blood, Spleen, Ventricles and substance of brain and cord—sterile.
17	370	Same dose and culture as with No. 16.	0.5 cc. serum from Rabbit No. 1. (Immunized with toxine from Bacillus X.) Mixed with bacteria immediately before inoculation.	36 days.	Slight area infiltrated at seat of inoculation. Entire lungs in red hepatization.	Seat of inoculation—sterile. Heart's blood—staphylococci. Spleen—staphylococci. Brain and cord—sterile.
18	810	0.81 cc. 70-hr. plain bouillon culture of B. diphtheriæ (series De C).	Not protected.	1½ days.	Considerable œdema and congestion at seat of inoculation. Kidneys congested. Liver and spleen pale.	Same as in No. 16.
19	140	0.28 cc. same culture as with No. 18.	0.3 cc. same serum as with No. 17.	26 days.	Right lung œdematous.	Same as in No, 17, except spleen sterile.
20	150	0.15 cc. 7-hr. plain bouillon culture of known B. diphtheriæ (series W. W.).	Not protected.	2½ days.	Intense congestion and œdema at seat of inoculation. Kidneys and adrenals congested. Spleen enlarged. Liver pale, mottled.	Same as in No. 16.
21	115	0.12 cc. same culture as with No. 20.	0.5 cc. same serum as with No. 17.	Still alive after 96 days.		

It will be seen from the experiments recorded in Table I. that the bacillus under investigation possessed an ordinary degree of virulence, that the autopsy findings were the same as those in death from known diphtheria bacilli, that in every instance the organism was recovered in pure culture and unchanged morphologically or culturally from the seat of inoculation (though from no other part of the body), and that diphtheria antitoxine invariably protected against otherwise fatal doses of the organism

For experimental purposes a toxine was prepared by growing the bacillus—tenth generation from the original source—for twenty-three days in sugar-free bouillon in the incubator, and filtering through a Chamberland filter. Its toxicity was then tested, with the results shown in Table 23, p. 568.

Rabbit No. 1, weight 2,860 grammes, whose serum had been shown by inoculation tests to be not anti-diphtheritic, was then immunized by increasing doses of the toxine prepared as described above, and finally by inoculation with a living culture of the bacillus. The rabbit was then bled and its serum used as noted in the experiments given in Table 24, p. 569.

Inoculations to determine the presence of the virus of rabies. About 0.5 ccm. from the central portion of the medulla of Mrs. R., received as noted above, was removed in a sterile manner, and with sterile 0.67 per cent sodium chloride solution made into as thick an emulsion as could be passed through an ordinary hypodermic needle. With this emulsion the following inoculations were made:

Rabbit No. 2, weight 1,120 grammes. Inoculated Dec. 15, 1897, 11 a. m., in left subdural space with 0.2 ccm. of emulsion above mentioned.

Appeared perfectly well until 9 a. m. Jan. 4, 1898, twenty days after inoculation, at which time it showed disinclination to move, and when made to hop exhibited weakness in posterior extremities, with slight incoördination. Temperature 35.7° C.; 11:30 to 12 m. incoördination became much more marked. Animal very restless, moving about constantly and grinding its teeth frequently. During afternoon animal remained quiet. Jan. 6, 1898, 9 a. m., rabbit found lying on side, stretched out, head thrown backwards, all power of motion in posterior extremities apparently gone. Temperature 35.5° C.; 1 p. m., condition unchanged. Sniffed at food which was placed near nose, but did not attempt to eat. (Culture from throat taken at 5 p. m., Jan. 4, showed staphylococci, streptococci and short, slender bacilli, unidentified.) Jan. 6, 8

p. m., twenty-two days after inoculation, rabbit was found dead and in rigor mortis.

Autopsy 9 p. m., Jan. 6. Marked injection of vessels of pia; minute extradural plastic exudate at seat of inoculation; mouth and trachea clear of mucus; vessels of trachea not congested; small light-colored patch on inferior border of median lobe of liver; bladder much distended and its vessels injected; other organs normal.

Cultures made from pia, fourth ventricle, and heart's blood all remained sterile. Those from substance of medulla gave abundant pure growth of a bacillus, with the same morphological and cultural characteristics as that obtained from the original source and identified as the diphtheria bacillus.

Rabbit No. 3, weight 1,270 grammes. Inoculated at same time (Dec. 15), in the same manner, and with the same substance and dose as Rabbit No. 2.

Jan. 5, 9 p. m., twenty-one days after inoculation, animal showed first symptoms. History similar to that of Rabbit No. 2, except that at no time was any excitement present, and that much flowing of saliva was noted throughout the second day after the appearance of symptoms. Death Jan. 6, at 11 p. m., twenty-two days after inoculation.

Autopsy findings parallel with those of No. 2, except that the throat was filled with mucus and the trachea was slightly injected in upper portion. The liver was apparently normal. Cultures from surface of brain at seat of inoculation and heart's blood remained sterile. Those from substance of medulla developed pure growth of B. diphtheriæ.

Though the Bacillus diphtheriæ was recovered in pure culture from the central nervous system of Rabbits Nos. 2 and 3, yet the clinical history and gross autopsy findings in the animals were so like those observed in rabbits inoculated subdurally with the virus of known rabies that it was impossible to decide whether death had been caused by the virus of rabies, by the diphtheria bacillus, or by a combined infection with the two. Hence, the following inoculations were made from the substance of the medulla of Rabbit No. 2:

Rabbit No. 4, weight 1,390 grammes. Inoculated 2 p. m., Jan. 6, 1898, in left subdural space with 0.2 ccm. of thick emulsion of medulla of Rabbit No. 2 in 0.67 per cent NaCl. solution. (A small quantity of the emulsion escaped from the wound in the dura on the withdrawal of the needle).

Rabbit remained apparently well up to and including 4 p. m., Feb. 1, 1898. Found dead and in rigor mortis 9 a. m., Feb. 2, twenty-seven days after inoculation.

At autopsy animal very much emaciated. Pia slightly congested. Trachea normal. Liver congested, not markedly enlarged. Gall bladder much distended. Urinary bladder distended. All other gross findings negative. Cultures from surface of pia, heart's blood and gall bladder all remained sterile after seven days in the incubator. Those from the substance of the medulla developed a few colonies of B. diphtheriæ.

Rabbit No. 5, weight 1,030 grammes. Inoculated Jan. 6, 2 p. m., in left subdural space with 0.2 ccm. of the same emulsion as that used in inoculating Rabbit No. 4 (i. e., medulla in physiological salt solution).

Jan. 23, 10 a. m., seventeen days after inoculation, the rabbit showed disinclination to move; when compelled to hop exhibited slight posterior incoördination. Temperature 38.5°, 5 p. m. Symptoms grew rapidly worse during afternoon—animal lying on side with posterior limbs completely paralyzed. Found dead Jan. 24 at 9 a. m., eighteen days after inoculation.

Autopsy. Body not emaciated. Meninges very intensely congested. Trachea slightly congested. Heart and adjacent vessels engorged with blood. Liver very dark, congested, enlarged and friable. Spleen pale. Right kidney slightly congested. Other gross findings negative.

Serum and broth cultures from the meninges and substance of medulla gave a few colonies of B. diphtheriæ. Similar cultures from the ventricles of the brain, the heart's blood and the spleen remained sterile after five days in the incubator.

Rabbit No. 6, weight 1,210 grammes. Inoculated Jan. 6, 1898, 2 p. m., in left subdural space with 0.2 ccm. of emulsion prepared by rubbing up an unmeasured portion of the medulla of Rabbit No. 2 with P., D. & Co.'s diphtheria antitoxine (date of Oct. 9, 1897, 2,000 units to bulb.) The emulsion was as thick as could be passed through the needle of a hypodermic syringe.

This rabbit has shown no symptoms up to the present time, 130 days after the inoculation.

Rabbit No. 7, weight 970 grammes. Was inoculated Jan. 6, 1898, in the left subdural space with 0.25 cc. of the same emulsion as that used in inoculating Rabbits Nos. 4 and 5. Immediately preceding this inoculation the animal had been given subcutaneously in the right groin 1 cc. (about 500 units) of anti-diphtheritic

serum (P., D. & Co.'s issue of Oct. 9, 1897.) This rabbit has exhibited no symptoms up to the present time, 130 days after the inoculation.

The extreme difficulty of procuring rabbits at the time of death of Nos. 4 and 5, coupled with the strong belief that Nos. 6 and 7 would eventually die of rabies, was deemed sufficient reason for not carrying forward the series from the medullæ of those already dead.

Effects of association of the virus of rabies with diphtheriae antitoxine and B. diphtheriae. The experiments on Rabbits Nos. 6 and 7 indicate that the virus of rabies was absent from the material used to inoculate these animals, and presumably also from the medulla of the patient, but before this inference could be justifiably drawn it was necessary first to determine what influence diphtheria antitoxine may have upon the virus of rabies or upon a combination of this virus with the diphtheria bacillus.

In numerous experiments made in this laboratory large doses of anti-diphtheritic serum have been administered subcutaneously to rabbits just prior to their inoculation with the fixed virus of rabies, and in other instances with the virus of street rabies, without any appreciable effect either on the time of onset or the character of the symptoms. Equally without effect upon the manifestations of rabies was the mixture of the rabic virus with diphtheria antitoxine before inoculation of the animal.

The experiments recorded in Table 25, (p. 574) were made to determine the effect, if any, on the incubation period, symptoms, etc., of inoculation of rabic virus simultaneously with diphtheria antitoxine and diphtheria bacilli.

TABLE NO. 25.

INOCULATION OF RABBITS WITH RABIC VIRUS COMBINED WITH DIPHTHERIA BACILLI AND DIPHTHERIA ANTITOXINE.

No. of rabbit.	Weight in grammes.	Inoculation.	No. of days to onset of symptoms.	Symptoms.	No. of days from inoculation till death.	Autopsy.
P. 85. (control)	1460	In left subdural space with 0.2 cc. of emulsion of 0.2 cc. of medulla rabbit dead of inoculation with the fixed virus of rabies mixed with 0.5 cc. of plain broth.	7	Short period of excitement followed by stupor; posterior incoördination; ascending paralysis; retraction of head; escape of much saliva from mouth; death in coma.	13	Meninges and trachæ slightly congested. Bladder distended. Serum and broth cultures from meninges and heart's blood sterile after 48 hrs. incubation.
P. 86	1520	Same as No. P. 85 except 0.5 cc. of P., D. & Co.'s diphtheria antitoxine (500 units) used instead of broth. Emulsion inoculated with 1 loopful of a 40-hr. broth culture of B. diphtheriæ ½ hour before inoculation into rabbit.	7	Same as No. P. 85.	13	Same as No. P. 85.
P. 87 (control)	3050	Same as No. P. 85 except medulla of another rabbit (dead of fixed virus of rabies) used.	7	Same as No. P. 85.	12	Same as No. P. 85.
P. 88	2380	Same as No. P. 87 except 0.5 cc. (500 units) P., D. & Co.'s diphtheria antitoxine used instead of plain broth. Emulsion inoculated 1 hr. before use with 1 loopful of a serum culture of a virulent B. diphtheriæ.	7	Same as No. P. 85.	11	Same as No. P. 85.
268 (control)	1300	In left subdural space with 0.2 cc. of emulsion of 0.2 cc. of medulla of rabbit No. 266 (original from street rabies, Case 33) made up with 0.5 cc. of plain broth.	13	Excitement followed by stupor; posterior ascending paralysis; retraction of head; much saliva escaping from mouth; death in coma.	15	Slight meningitis; trachea congested; bladder distended. Cultures from seat of inoculation and heart's blood sterile after 48 hrs. in incubator.

TABLE NO. 25.—*Continued.*

No. of rabbit.	Wt. in grammes.	Inoculation.	No. of days to onset of symptoms.	Symptoms.	No of days from inoculation till death	Autopsy.
269	1420	In same manner, dose and medulla as with No. 268, but emulsion made by using 0.2 cc. of medulla to 0.5 cc. of P. D. & Co.'s diphtheria antitoxine (500 units). The emulsion was inoculated ½ hr. before use with 1 loopful of 40-hour broth culture of virulent B. diphtheriæ.	14	Slight excitement of animal noticed on day following inoculation which subsided within 18 hrs. No further symptoms till the 14th day, when began the usual course as observed in rabbits suffering from rabies.	16	Same as in No. 268, and in addition liver slightly congested.
270 (control)	2050	Same in every respect as No. 268 except that the medulla of rabbit No. 267 (mate to No. 266, original from street rabies, case 33) was used.	19	Same as No. 268.	21	Same as No. 268.
271	2000	Same as No. 269 except same medulla as used with No. 270 and emulsion inoculated with 1 loopful of 24-hr. serum culture of virulent B. diphtheriæ ¼ hr. before use.	20	Three days after inoculation rabbit excited, showed some posterior incoördination; 24 hours later less excited; incoördination very slight; ate food freely. 72 hours later animal apparently perfectly well. No further symptoms until the 20th day after inoculation when began the usual course as in No. 268.	24	Same as No. 268. except small hæmorrhagic area—subdural—at site of inoculation.

It will be observed from Table 25 that Rabbits Nos. P85, P87, 268, 270, were used merely as controls, the first two being inoculated in the ordinary manner with the fixed virus of rabies from two different animals, and the last two with the virus of street rabies, second generation from a rabid dog. In Nos. P86 and P88 the addition of diphtheria antitoxine and virulent *B. diphtheriae* to the fixed virus some time before inoculation did not appear to alter in any way either the incubation period, the train of symptoms, or the autopsy findings. Rabbits Nos. P109, P111, P113, P115, P117 and P121 of Table 26, may also be cited in this series. The diphtheria bacilli had been in contact with the living nerve tissue and rabic virus for from two to fifteen days in the material with which these latter animals were inoculated, yet the rabic virus appeared unchanged thereby.

In Rabbits Nos. 269 and 271, in the inoculation of which to the rabic virus had been added diphtheria antitoxine and virulent diphtheria bacilli, symptoms of slight cortical irritation were present on the first and third days, respectively, after trephining. These symptoms rapidly disappeared and the animals remained well until the expiration of the ordinary incubation period of street rabies, when they exhibited the same train of symptoms as their controls, and after death gave the same autopsy findings.

The foregoing experiments demonstrate that the medulla of Rabbit No. 2 (dead twenty-two days after inoculation with an emulsion of the medulla of Mrs. R.) could not have contained the rabic virus, for if this virus had been present it would have manifested itself in Rabbits Nos. 6 and 7, which were inocuated with the medulla of Rabbit No. 2, combined with diphtheria antitoxine.

The question may, however, still be raised whether a combined infection with rabies and diphtheria may not have existed in the patient, and that only the virus of diphtheria was transmitted to the rabbits inoculated with her medulla. As the ultimate findings could not be anticipated, the opportunity of determining the protective influence of diphtheria antitoxine upon the animals inocuated directly with the medulla of the patient was unfortunately lost.

Inasmuch as Roux* found that the medula and cord of an animal inoculated four days before with fixed virus—that is, three days before the appearance of symptoms—were capable of producing rabies when inoculated into other animals, it seems most improbable that the virus of rabies should not, if it were originally present

Annales de l'Institut Pasteur, 1889, iii, 77 and 1888, ii, 24.

in the medulla of the patient, have been demonstrable in the medullæ of the rabbits inoculated with this medulla and dying twenty-two days after the inoculation.

In order to shed further light upon the question of the possibility of a mixed infection in the case of Mrs. R., the experiments recorded in Table 26 were undertaken to determine:

(a) How soon after subdural inoculation with the virus of rabies the medulla of a rabbit may contain sufficient virus to produce symptoms of rabies in other animals inoculated therefrom.

(b) The effect, if any, on the incubation period, course of symptoms, etc., in rabbits of inoculation with the medullæ of rabbits killed during the incubation period of rabies, by subdural inoculation of B. diphtheriæ.

It will be noted from Table 26 that the medullæ of Rabbits Nos. P103 to P107, inclusive, dying from diphtheria infection 7, 5, 4, 2 and 5 days, respectively, after subdural inoculation with the fixed virus of rabies were found to contain the virus of rabies apparently unchanged.

Rabbits Nos. 108 to 117, inclusive, comprising the second series of inoculations from the above showed the same incubation period, train of symptoms and post-mortem lesions as control rabbits inoculated in the ordinary manner with the fixed virus of rabies. Though from each of the emulsions used in inoculating these animals (Nos. P108-P117) B. diphtheriæ was grown in pure culture, yet the organism was recovered from the brains of but half of them after death. Its presence or absence seemed not to be determined by the use or non-use of diphtheria antitoxine in making up the emulsions, nor by the length of time elapsing from inoculation till death.

Nos. P120 and P121, the only animals inoculated in the third set, gave the incubation period, train of symptoms and autopsy findings of controls inoculated in the ordinary manner. Diphtheria bacilli were not recovered from their brains after death, though the organisms were present in small numbers in the emulsion from which they were inoculated.

In the light of the experiments recorded in Table 26 it does not seem possible to doubt that if the virus of rabies had really been present in the medulla of the patient, it would have been transmitted in demonstrable form to the medullæ of the rabbits inoculated therewith, but, as has already been shown, such transmission did not occur, and the inference is therefore warrantable that the rabic virus was absent from the patient's medulla.

Subdural inoculations of B. diphtheriae. Some experiments have been made in this laboratory, and others are now in progress, relating to the production of acute and delayed meningitis in rabbits by the subdural inoculation of pure cultures of B. diphtheriæ. The results of these, with report of tissue changes, are reserved until more extended observations have been made. One series, however, may be given here. B. diphtheriæ—nine generations removed from the original source—was grown twenty-three days in sugar-free bouillon and the following inoculations made:

Rabbit 8, weight 2170 g., received 0.05 cc. in left subdural space.
Rabbit 9, weight 2080 g., received 0.1 cc. in left subdural space.
Rabbit 10, weight 2000 g., received 0.2 cc. in left subdural space.
Rabbit 11, weight 1680 g., received 0.3 cc. in left subdural space.
Rabbit 12, weight 1800 g., received 0.4 cc. subcutaneously in the right groin.

Nos. 9, 10 and 11 died within twenty-four hours. At the autopsies was found acute meningitis, and B. diphtheriæ was discovered from the point of inoculation. No. 12 died on the fourth day.

No. 8 remained somewhat stupid for two days and then became apparently normal until the eighth day, when it showed great excitement if irritated, whirling about rapidly and rushing around the room in a frenzied manner, this attack lasting about one minute. These phenomena could, with gradually decreasing readiness, be produced by stimulation during a period of three days, after which they subsided altogether. The rabbit then remained in apparent good health until the twenty-third day after inoculation, when its posterior extremities were noticed to be weak and slightly incoördinated. On the following day they were completely paralyzed. The paralysis rapidly ascended. Forty-eight hours after the beginning of incoördination the rabbit was lying on its side with limbs extended, head retracted and breathing spasmodically. At no time during its final sickness was there any excitement observed nor any marked escape of saliva from the mouth. It may be mentioned, however, that the symptoms were difficult to distinguish from those exhibited by two rabbits dying from inoculation with the fixed virus of rabies and one dying from "street rabies"—second generation from a rabid wolf—which were under observation at the time in the same room with Rabbit No. 8. The animal died on the twenty-seventh day after inoculation.

Autopsy. General condition of rabbit good. Meninges not congested. Portion of left cerebrum about 1 cm. in superficial diameter and extending, at seat of inoculation, down to ventricle, was

TABLE NO. 26.

Serial Inoculations to Determine the Presence of the Rabic Virus in Rabbits Inoculated with this Virus and Subsequently Killed by the Diphtheria Bacillus.

First Set of Inoculations.							Second Set of Inoculations.							Third Set of Inoculations.						
No. of rabbits.	Wt. in grammes.	Inoculation.	No. of days from original inoc. to onset of symtoms.	Symptoms.	No. of days from original inoculation till death.	Autopsy.	No. of rabbit.	Wt. in grammes.	Inoculation.	No. of days to onset of symptoms.	Symptoms.	No. of days from inoc. till death.	Autopsy.	No. of rabbit.	Wt. in grammes.	Inoculation.	No. of days to onset of symptoms.	Symptoms.	No. of days from inoc. till death.	Autopsy.
P102 (control)*	2020	In left subdural space with 0.2 cc. of emulsion of 0.4 cc. of medulla of rabbit No. P. 101 (dead from inoculation of fixed virus of rabies) rubbed up with 1 cc. of plain broth.	7	Short period of excitement followed by stupor; posterior incoördination; ascending paralysis; retraction of head; escape of much saliva from mouth; death in coma.	12	Slight congestion of meninges and trachea. Bladder distended. Serum and broth cultures from meninges and heart's blood remained sterile after 48 hours in incubator.														
P103	1900	Same as No. P. 102, except that in addition 4 days later animal was given through original opening in skull 0.2 cc. of emulsion of 48-hour broth with a 48 hour serum culture of B. diphtheriæ.	5	Much excitement; posterior incoördination; ascending paralysis. (Excitement kept up longer than in rabies.) Death in coma.	7	Much congestion of meninges; no pus. Trachea congested. Serum and broth cultures from meninges showed B. diphtheriæ pure. Similar cultures from heart's blood remained sterile after 48 hours in incubator.	P116	990	Same as No. P. 102, but with emulsion made from medulla of rabbit No. P. 103 rubbed up with plain broth.	7	Same as No. P. 102, except shorter period from onset of symptoms till death. (This is almost always true with small rabbits.)	9	Same as No. P. 102.							
							P117	960	Same as No. P. 116, except with emulsion made by rubbing up 0.2 cc. of medulla of rabbit No. P. 103 with 50 units (0.5 cc.) of P. D. & Co's diphtheria antitoxine.	7	Same as No. P. 116.	9	Same as No. P. 103.							
P104	1960	Same as No. P. 103, except second inoculation given 3 days after first.	4	Same as No. P. 103.	5	Same as No. P. 103.	P112	930	Same as No. P. 102, except with medulla of rabbit No. P. 104 used for inoculation.	7	Same as No. P. 116.	11	Same as No. P. 103.							
							P113	880	Same as No. P. 112, except that 50 units P. D. & Co.'s diphtheria antitoxine were used in making emulsion.	7	Same as No. P. 116.	10	Same as No. P. 103.	P120	1220	Same as No. P. 116, except medulla of No. P. 113 used in making emulsion.	7	Same as No. P. 116.	10	Same as No. P. 102.
														P121	1420	Same as No. P. 120, except 50 uts. P. D. & Co.'s diphtheria antitoxine used in making emulsion.	7	Same as No. P. 116.	10	Same as No. P. 102.
P105	2470	Same as No. P. 103, except second inoculation given 2 days after first.	3	Same as No. P. 103.	4	Same as No. P. 103.	P110	2200	Same as No. P. 102, except with emulsion made from medulla of No. P. 105.	7	Same as No. P. 102.	14	Same as No. P. 102.							
							P111	1420	Same as No. P. 110, except 50 units P. D. & Co.'s diphtheria antitoxine used in making emulsion.	7	Same as No. P. 116.	10	Same as No. P. 102.							
P106	2190	Same as No. P. 103, except second inoculation given 1 day after first.	2	Same as No. P. 103.	2	Same as No. P. 103.	P108	2200	Same as No. P. 102, except emulsion made from medulla of No. 106.	7	Same as No. P. 102.	9	Same as No. P. 102.							
							P109	1980	Same as No. P. 108, except 50 units P. D. & Co.'s diphtheria antitoxine used in making emulsion.	7	Same as No. P. 102.	15	Same as No. P. 103.							
P107	2200	Same as No. P. 103, except 20-day broth culture of B. diphtheriæ used instead of plain broth in making emulsion.	1	Same as No. P. 103.	5	Same as No. P. 103.	P114	940	Same as No. P. 102, except emulsion made from medulla of No. P. 107.	7	Same as No. P. 116.	9	Same as No. P. 102.							
							P115	900	Same as No. P. 114, except 50 units P. D. & Co.'s diphtheria antitoxine used in making emulsion.	7	Same as No. P. 116.	10	Same as No. P. 102.							

*This animal forms one generation in the series used in this laboratory for the perpetuation of the fixed virus of rabies, and is noted here incidentally as a control in the inoculation of Nos. 103-107.

markedly softened. Membranes of cord slightly congested. Liver deeply congested. Urinary bladder much distended.

Cultures. From the softened area of the cerebrum no growth was obtained; from the medulla a few colonies on serum of B. diphtheriæ; from the heart's blood a few colonies of staphylococci.

SUMMARY OF PATHOLOGICAL REPORT.

1. The bacillus isolated from the central nervous system of Mrs. R. was Bacillus diphtheriæ, and doubtless such was the identity of the bacillus discovered in the nerve cells of the pons and medulla.

2. The histological lesions, as far as they were observed in the central nervous system and kidney, were the same as those observed after death from ordinary clinical and experimental diphtheria.

3. The subdural inoculations in rabbits of portions of the medulla of Mrs. R. produced symptoms simulating rabies in their time of onset and general character. The gross post-mortem findings in the animals resembled in their negative character those of rabies, but B. diphtheriæ was isolated culturally from the central nervous system. Synchronous inoculation of diphtheria antitoxine protected rabbits against otherwise fatal doses of the emulsions of the medullæ of the first series of rabbits.

4. The mixture of diphtheria antitoxine, or of diphtheria antitoxine and diphtheria bacilli, with the virus of rabies is without influence upon the manifestations of rabies.

5. The medullæ of rabbits inoculated with the fixed virus of rabies and killed during the period of incubation, two to seven days after the original inoculation, by subdural injection of cultures of the diphtheria bacillus, contain the virus of rabies in a form capable of transmitting rabies to rabbits inoculated in series with such medullæ.

6. The subdural inoculation of a small dose of pure culture of B. diphtheriæ, isolated from another source, produced symptoms which, in their time of onset and subsequent history, resembled in some degree those of rabies in rabbits.

I desire to express sincere thanks to Professor F. F. Wesbrook, under whose direction the above study has been conducted, to Dr. O. McDaniel and to Dr. E. Bates Block for their suggestions and criticism.

REVIEW AND CONCLUSIONS.

The history and the clinical symptoms in the case of Mrs. R. pointed toward the diagnosis of rabies. The well authenticated history of a bite on the cheek by an unknown animal, the two months' incubation period, the onset with extreme pain and numbness in the region of the scar, the development of the characteristic laryngeal and respiratory spasms on attempting to take liquids, the spasms at first being slight, later most pronounced, and toward the close feeble or absent, the insomnia, the absence of fever in the beginning, which later in the disease became pronounced, the rapid pulse at all stages, the attacks of violent delirium interspersed with periods of calm and complete rationality, the absence of all symptoms pointing toward any other simulating disease, and the fatal termination, all serve to make an almost complete picture of rabies.

One feature of the case not in harmony with the diagnosis of rabies is the long period over which the disease continued prior to the fatal termination. As is seen from the history, the course of the illness, dating from the onset with pain, sleeplessness and mental depression, lasted fourteen days. If time is estimated from the onset of the first laryngeal spasm, ten days elapsed before the fatal outcome. On the other hand, most authorities place the death limit in rabies at five to eight days.

A second clinical feature manifested in this case, which does not appear to correspond to the usual symptom-complex in rabies, is the presence of a large amount of albumin and of casts in the urine. Most of the clinical writers make no mention of such a complication in rabies. Roger,* however, speaks of the occurrence of dysuria, albuminuria and glycosuria in rabies, and he cites Samson and Chippindale as having noted hæmoglobinuria and the presence of casts.

The gross pathological findings likewise seemed to confirm the clinical diagnosis, since the post-mortem examination revealed no lesions aside from mild cerebral congestion. But the value of such confirmation is slight, in view of the fact that no characteristic gross lesions of rabies have hitherto been determined by any observer, and a confirmation based on negative pathological conditions is of doubtful value. The microscopical changes found in

*Roger, Article "Rage" in Charcot, Bouchard and Brissaud's Traité de Médecine, T. i, p. 608. Paris, 1891.

the nervous centers, although definite, are not of decisive diagnostic significance.

An unexpected and important discovery was the finding of the Klebs-Löffler bacillus in the ventricular fluids and in the tissues of the medulla oblongata of the patient. The presence of the bacillus in microscopical sections confirmed the cultural results, and especially to be emphasized is the demonstration of characteristic diphtheria bacilli within nerve cells. The determination of the identity of the bacillus with the genuine Bacillus diphtheriæ was so complete that there can be no room for doubt upon this point. The bacillus was of ordinary virulence and produced toxine and led to the generation of antitoxine identical with diphtheria toxine and antitoxine.

Not less suggestive of rabies than the clinical history of the patient were the results of subdural inoculations of rabbits with emulsions prepared from the medulla of the patient. There occurred the long period of incubation (twenty and twenty-one days), followed by phenomena similar to those in experimental rabies of rabbits, and the rabbits inoculated subdurally with the medullæ of the first rabbits behaved in a similar manner.

But here again the Bacillus diphtheriæ, which was present in the medulla of the patient, was demonstrated with similar distribution in the rabbits' medullæ.

Of decisive significance in the interpretation of the case is the demonstration that the mixture of the emulsion of the medullæ of the first series of rabbits with diphtheria antitoxine, as well as the injection of antitoxine followed by inoculation of the medullæ, prevented the appearance of any abnormal symptoms after subdural inoculation, whereas in control experiments diphtheria antitoxine manifested no appreciably protective influence as regards either the fixed virus of rabies or the virus of street rabies. It is, therefore, justifiable to infer that the virus of rabies was not present in the medullæ of the rabbits inoculated directly with the medulla of the patient, for otherwise it should have been capable of demonstration after the neutralization of the diphtheria toxine by anti-diphtheritic serum. Although the opportunity to mix diphtheria antitoxine with the medulla of the patient was lost, the experiments recorded in Table 26 justify the conclusion that if the virus of rabies had been present in combination with the diphtheria bacillus in this medulla it would have been transmitted in demonstrable form to the medullæ of the rabbits inoculated therewith and dying twenty-two days afterward. As such transmission

is excluded by the results of the inoculation of Rabbits Nos. 6 and 7, the absence of the virus of rabies from the patient's medulla must be regarded as established.

We are forced, therefore, to the conclusion that the case reported in this paper was one of infection of the central nervous system with the diphtheria bacillus, and not one of rabies, and this conclusion is confirmed by the experimental reproduction of a similar localization with a prolonged period of incubation by the subdural inoculation of a rabbit with 0.05 cc. of a twenty-three days' bouillon culture of the diptheria bacillus (p. 578).

The portal of entry of the bacillus was not determined. There was no positive evidence of diphtheria in the throat, although the existence of the diphtheria bacillus in this situation was not excluded. The possibility that the patient was inoculated with the diphtheria bacillus through the wound, and that it traveled along the nerves to the nervous centers, in the manner of the rabid virus, may be suggested, but of this there was no proof.

The close simulation of rabies, both clinically and experimentally (a simulation all the more remarkable on account of the previous history of a bite on the cheek, followed by the usual period of incubation of rabies), by cerebral infection with the diphtheria bacillus is certainly most curious and interesting. We have abundant evidence that the cerebral localization of various infectious agents, such as those of tuberculosis, of tetanus, etc., may be attended by morbid phenomena very unlike those of the ordinary localizations of the same agents elsewhere in the body, and our case demonstrates that the same may be true for the diphtheria bacillus.

STUDIES ON THE DISTRIBUTION OF CERTAIN VARIETIES OF THE DIPHTHERIA BACILLUS. *

BY F. F. WESBROOK, M. D.; L. B. WILSON, M. D.; O. McDANIEL, M. D.

(From the Minnesota State Board of Health Bacteriological Laboratory.)

In a former paper from this laboratory entitled, "A Preliminary Communication on Bacillus Diphtheriæ and Its Variants in a School in Which Diphtheria Was Endemic," the conditions of life favoring ready throat to throat infection were pointed out.

This school (see photographs on exhibition at meeting) consisted of five residence cottages, an administration building, in which meals were served and chapel held, a detention building for the reception of incoming children, a hospital, two school houses (one incompleted), stables and an engine house, including laundry, etc.

The 250 children come from different portions of the state to the school, and are there housed, educated, etc., for a period averaging about one year, when they are placed in suitable homes throughout the state.

Diphtheria has been endemic in this school since its establishment in 1887. The occurrence of an outbreak in 1896 and the results of bacteriological investigation were also reported in the former communication above mentioned.

Though the clinical cases became fewer, the persistence of a widespread infection of the throats of the children seemed to be a menace to the health of the school and the state at large, and efforts to prevent this throat to throat infection were made.

The placing of all cases of sore throat and all healthy children whose throats were found to be infected with B. diphtheriæ, in a building, where, as a small isolated colony, they led a separate existence until two successive negative throat examinations showed them clear of diphtheria-like forms, did not prove to be of any avail.

*Read before the Section of Bacteriology and Chemistry of the American Public Health Association Oct. 31, 1899, and published in the Transactions American Public Health Association for 1899, page 546, et seq.

It may be mentioned that one little boy was kept in this building for nineteen months and two days, and that his throat continued to show bacilli of alternating morphology and of virulence for guinea pigs, whenever tested, all this time.

It was therefore felt, owing to the fact that attempts to isolate infected children had proven so ineffective that half the inmates of a single cottage showed infection, something more radical was demanded. The ground was looked over again most thoroughly and though examinations of milk, water, earth, etc., yielded negative results, so far as the finding of B. diphtheriæ was concerned. toys, etc., showed its presence.

The necessity of sending cultures so far (80 miles) for examination permitted the possibility of these children, whose throats might be germ free at the time of taking, to become infected again from their fellows before the diagnosis could be obtained and acted upon.

Opportunities for infection from child to child were so numerous that the former plans of attempted isolation, etc., were abandoned and the following adopted.

To avoid delay in making and transmitting diagnoses, a bacteriologist's presence was essential, and Dr. McDaniel was placed in charge of a local branch laboratory. The details of the carrying out of this plan have been given on page 465, et seq., of the Biennial Report of the Minnesota State Board of Health, 1897-98, a portion only of which is quoted:

"It was therefore suggested that in one of the buildings a large number of small rooms be constructed, so as to secure absolute individual isolation, and the whole school gradually passed through this filter, as it were, and that the germ-free filtrate be kept absolutely separated in every way from those who had not yet been through the filter and be housed in a freshly sterilized building; that as soon as the clean filtrate became sufficiently large to warrant it, the others or infected children be confined and isolated."

It was successful, and nearly all of the inmates had been passed through the isolation building and the freedom of their noses and throats from diphtheria bacilli established by at least three successive negative results of examination for each, when upon again examining the supposedly germ-free children, who had been housed in freshly sterilized buildings, the percentage of infection was found to be nearly as great as before.

This plan was then abandoned. The fact that it was impossible to subject all the attendants to a similar process of "filtration" and

that they were not by reason of special training so keenly alive to the possibilities of reinfection may be offered in explanation of this. It was felt both by the school authorities and the State Board of Health that the most thorough attempt to rid the school of the condition which had so long menaced the public health was obligatory. It is easier now than at the beginning to see the difficulties in the way.

The effects of the isolation, and the thorough looking over to which the children were subjected, as well as the local treatment of nose and throat in ridding them of diphtheria bacilli, had an apparent beneficial effect upon the general health of the school.

SYNOPSIS OF RESULTS OF CULTURAL EXAMINATIONS MADE FROM THE THROATS AND NOSES OF 263 HEALTHY CHILDREN DURING COMPLETE INDIVIDUAL ISOLATION.

In all two hundred and sixty-three children passed through the isolation wards, during the course of which over five thousand examinations were made.

The following are some of the interesting points obtained by an analysis of the records of these examinations:

I. Sixty-six of the children (25 per cent) showed no diphtheria-like organisms in either *nose* or *throat* at any time during their period of isolation. An average of over six examinations was made for each of these children.

II. In the remaining 197 children the throat or nose, or both, were found to be infected with some of the "typical"[1] (i. e., granular or irregularly stained forms of bacillus diphtheriæ), or with the "atypical" form of the organism designated in this paper as groups 1 and 2, respectively. (See description of types which precedes Tables A and B.)

After the first examinations of cultures from both nose and throat taken at the same time, on the discovery of either group of B. diphtheriæ in either nose or throat, or both, cultures were usually taken thereafter from the nose alone until its freedom from any form of B. diphtheriæ was established, when synchronous cultures were taken from both nose and throat, as it had been found that the microbes were more persistent in the nose. This was continued until three successive examinations of cultures from both nose and throat (six in all) gave negative results.

The distribution of the bacilli in the infected children in an average of twenty-three examinations each may be expressed by the following tables:

In these tables by "Group I" is meant those forms of bacilli which when found in clinical cases are ordinarily diagnosed as "B. diphtheriæ," and which when tested in pure culture on guinea pigs are usually virulent. It includes the following (illustrated by stained microscopic specimens and by colored charts drawn to scale from stained specimens).

These type cultures have been obtained from:

(a) Ordinary clinical cases;

(b) Healthy children.

(1) During complete individual isolation;

(2) Healthy school children.

The ordinary cultures were examined and from them by dilution, violent shaking and subsequent streaking out, isolated colonies were obtained. From these, sowings in a similar manner were made. This was repeated from three to fifteen times during a period of from one month to two years. This does not, of course, mean that any colony from which subsequent sowings were made is necessarily developed from an individual bacillus, though the probability is that it is so in many instances.

It must be understood that it is rare except in types D^2 and E^2 for any single type to occur as the sole representative of B. diphtheriæ in direct cultures from nose or throat.

For the interpretation of staining peculiarities it may be mentioned that all cultures were grown on Löffler's serum (containing 1.25 per cent. glycerine) from 18 to 24 hours in the incubator. Specimens are stained with Löffler's methylene blue. This is true of all cultures whether pure or as they were obtained from throats and noses.

GROUP I.

Type A—1 to 2 microns thick by 3 to 6 microns long; granular or very lightly staining clubbed variety with markedly irregular outlines. i. e., the "ghost," "dumbell," and "clubbed" forms of other observers. Apparently an involution form of B. C. and B^1.

Type B—0.5 to 0.75 microns thick by 3 to 7 microns long; long relatively slender forms which stain lightly except where granules occur at irregular intervals, but more frequently at one pole. The granules (1 to 4 in each bacillus) are ellipsoid and placed with their long diameters lengthwise of the bacillus. Their cross diameter is not greater than that of the rest of the bacillus. They are ordinarily dark blue (showing no trace of red). This form is not of frequent occurrence.

Type C—0.5 to 1 microns thick by 3 to 4 microns long; often somewhat curved forms in which protoplasm stains light blue except always at poles and occasionally in one point between the poles where rounded, rarely ellipsoid granules occur. These granules stain dark blue with a marked reddish tinge, and are thicker than the rest of the bacillus.

This form is the most common met with in clinical cases, and may perhaps be considered the type of the "long" form of bacillus diphtheriæ as contrasted with the "short" form usually spoken of by most observers.

Type D—0.75 to 1 microns thick by 2 to 3 microns long. Similar in most respects to C., but shorter and thicker and apparently straighter.

Type E—0.5 to 0.75 microns thick by about 1.5 microns long. Otherwise like D. D. and E. comprise probably the "short" forms of bacillus diphtheriæ of other observers.

Type B^1—0.5 microns thick by 3 to 6 microns long; long curved forms usually thicker at one end, or straight forms thicker in the middle with bluntly pointed ends. Its characteristic is a dark blue color with 4 to 8 lightly stained or white transverse bands.

In the experience of this laboratory this form is infrequently met with, though commonly figured in text books, etc.

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1 See British Medical Journal, April 16, 1898, "A Preliminary Communication on Bacillus Diphtheriæ and Its Variants in a School in Which Diphtheria was Endemic."

Type D^1—0.5 to 1 microns thick by 2 to 3 microns long. As compared with B. this form is shorter, has fewer bands and is usually straighter. B^1 and D^1 stain dark blue, and show no reddish tinge as do the granules in C. D. and E.

Type C^2—0.5 to 1 microns thick by 3 to 4 microns long; curved or straight forms usually slightly clubbed or tapering at both ends. Stains a fairly uniform intense blue, no reddish tinge. Infrequently met with.

GROUP II.

Type F—0.25 to 0.5 microns thick by 1 to 2 microns long. Small slender bacilli, with tapering extremities. The bacilli stain light blue and contain one or two rounded granules of an intense dark blue with a reddish tinge. The granules occur at one end or near the middle, or in both places. The granules are thicker than the rest of the protoplasm which tapers from their point of occurrence towards the ends. This form is extremely rare, and its pathogenesis has not yet been tested.

Type G—0.5 to 0.75 microns thick by 1 to 1.5 microns long. Shortest granular form. Bacilli usually paired. Each pair resembles a dark blue ellipsoid divided transversely by a clear narrow space. Granules are very small and occur only at the distal extremities of the pairs. They stain an intense blue, and occasionally show a slight trace of red. Has been very rarely found in clinical cases, though its pathogenesis for guinea pigs has been shown in cultures from a non-clinical case.

Type D^2—0.75 to 1 micron thick by 1 to 2.5 microns long. Bacilli usually in pairs, with opposing extremities flattened and thickened. The distal extremities are bluntly pointed or abruptly rounded. Stain an intense even dark blue. (No reddish tinge.)

This is the type to which particular attention was drawn in a former communication as the "atypical" form of B. diphtheriæ. It is the most prevalent form at Owatonna, is occasionally the only form present in clinical cases, and is frequently pathogenic to guinea pigs, and when so can be immunized against by the use of commercial diphtheria antitoxine. This is the prevailing type of Group II.

Type E^2—0.5 to 0.75 microns thick by 1 to 2 microns long. Very like D^2, except that it is smaller and apparently straighter. D^2 and E^2 are probably included under the "pseudo-diphtheria" group of bacilli of other observers.

Type G^2—0.5 to 0.75 microns thick by 1 to 1.25 microns long. A bacillus resembling D^2 and E^2 in staining and arrangement, but shorter. Has almost diplococcus appearance and resembles G. except for the presence of granules.

TABLE NO. 27.—(INFECTED CHILDREN.)

No.	Throat Examinations. Variety of Bacillus Present.	Throat Examinations. When Present.	Nose Examination. Variety of Bacillus Present.	Nose Examination. When Present.	No. of Children.	% of Total Infection.
1	....	....	Group I........	Throughout........	21	11
2	Group I,........	Throughout........	....	....	25	12½
3	....	....	Group II........	Throughout........	115	58
4	Group II........	Throughout........	....	....	60	31
5	....	....	Both Groups........	Alternating........	45	23
6	Both Groups........	Alternating........	....	....	33	17
7	....	....	Both Groups........	Concurrent*........	9 (4)	5 (2)
8	Both Groups........	Concurrent........	....	**	3 (1)	1½ (½)
9	Group I........	Once at least........	None........	Never........	5	2½
10	Group II........	Once at least........	None........	Never........	7	3½
11	None........	Never........	Group I........	At least once........	26	13
12	None........	Never........	Group II........	At least once †........	67 (42)	33 (26)
13	Group I........	Synchronous at least once........	Group I........	Synchronous at least once........	14	7
14	Group II........	Synchronous at least once........	....	Synchronous at least once........	50	25
15	Group II (Synchronously with Group I in Nose)...	At least once........	Group I (Synchronously with Group II in Throat)	Synchronous at least once........	10	5
16	Group I (Synchronously with Group II in Nose).	At least once........	Group II (Synchronously with Group I in Throat)	Synchronous at least once........	7	3½
17	None (Synchronously with Group I in Nose)...	....	Group I (Synchronously with None in Throat)...	....	25	13
18	None (Synchronously with Group II in Nose).	....	Group II (Synchronously with None in Throat)...	....	97	49
19	Group I (Synchronously with none in Nose)......	....	None (Synchronously with Group I in Throat)	....	13	6½
20	Group II (Synchronously with none in Nose).....	....	None (Synchronously with Group II in Throat)	....	25	13

TABLE NO. 28. (NUMBERS AT MARGIN CORRESPOND WITH TABLE A.)

No.	THROAT EXAMINATIONS.	No. of Cases.	% Infected.	% Free.
2	Group I alone present	25	12½	....
4	Group II alone present	60	31	....
6	Alternation of Groups I and II	33	17	....
8	Concurrence of both Group cases not already included in No. 6 **	1	½	....
11	Absence of both groups though Group I was present in nose at time of examination	26	....	13
12	Absence of both groups though Group II was present in nose at time of examination.†	52	....	26
	Totals	197	61	39
	NOSE EXAMINATIONS.			
1	Group I alone present	21	11	....
3	Group II alone present	115	58	....
5	Alternation of Groups I and II	45	23	....
7	Concurrence of Groups I and II not already included in No. 5.*	4	2	....
9	Absence of both groups though Group I was present in throat at time of examination	5	....	2½
10	Absence of both groups though Group II was present in throat at time of examination.	7	....	3½
	Totals	197	94	6

FOOT NOTES FOR TABLES A AND B.

*Five of these cases were included in both Nos. 7 and 5, i. e. Concurrence occurred in 2 per cent. not already included in list of Alternations.

**Two of these cases were included in both Nos. 6 and 8, i. e. Concurrence occurred in ½ per cent. not already included in list of Alternations.

†Only 52 cases (26 per cent.) are not already included in No. 11, i. e., in certain cases where both groups were at all times absent from the Nose, there was mixture of the groups in the Throat.

As will be seen from the foregoing tables, the bacilli included in group I. were found in the throats and noses less frequently than were those included in group II., though present in 11 per cent of the noses and 12½ per cent of the throats as the sole diphtheria-like organisms throughout the course of examinations.

The concurrence and alternation of groups I. and II. in throats or noses adds to this number so as to show group I. present in the nose in 38 per cent of all cases and in the throat of 30 per cent of all cases.

Group II. was present then either alone, mixed or alternating with group I., in the throat in 48½ per cent.

It will thus be seen that noses (94 per cent) were more frequently found infected than throats (61 per cent), and that in the nose group II. was found nearly twice as frequently as in the throat, whilst group I. was nearly as often present in the nose as in the throat. Whether these findings would have been changed by synchronous, and as frequent, examinations of the throat as of the nose, cannot be known, though the results of several hundred examinations had *not* seemed to indicate it.

The members of group II. (particularly types D^2 and E^2) seem to be tolerably fixed types of the bacillus, when studied in young serum cultures and stained by Löffler's methylene blue, though they may under certain cultural conditions be replaced by or perhaps changed into bacilli which belong to group I. The opinion expressed in the former communication from this laboratory must be, in this particular, somewhat modified.

This comparative stability of morphology in group II. may then account for its much more frequent presence in the children examined, particularly in the noses, though, as will have been seen in the throats, the two forms are more even in distribution.

This stability of type in group II. is strikingly illustrated by the comparative rarity of concurrence, though alternation (see Tables A and B, items Nos. 5 to 8) is more frequent, particularly in the throat. In this connection, it must not be forgotten, however, that group I. was found alone throughout all examinations more frequently in the throat than in the nose (see Tables A and B, Nos. 1 and 2), whilst group II. occurred as the sole diphtheria-like organism more frequently in the nose than in the throat (Tables A and B, Nos. 3 and 4), hence it may be inferred that the admixture of group II., from the nose, with group I., in the throat, may be facilitated by gravity. The concurrence of forms in either nose or throat was too infrequent to warrant any deductions, which may

be also true of the alternations. Gravity, too, and mechanical cleansing, swallowing of foods, drinks, etc., must not be lost sight of in considering the more frequent finding of bacillus diphtheriæ in the nose than in the throat.

The more frequent occurrence of one or both groups in the nose of cases whose throats were diphtheria-bacillus-free at all times (Table B, Nos. 9 and 10) than was the case in the converse (Table B, Nos. 11 and 12) may possibly be explained by the fact that both groups were less often found in the throat than in the nose. Probably more frequent synchronous infection of nose and throat with the same or different groups (see Table A, Nos. 13 to 16) would have been found had throat examinations been made more frequently throughout the period of isolation, but it will be remembered that, as a rule, after the first few examinations, throat cultures were not again taken until the nose had been found free of all members of both groups, as the nose had shown more frequent infection.

These synchronous findings, either as regards the same or different groups in the nose or in the throat, were, of course, included in some previous part of the table. From the frequent temporary disappearance of members of both groups from either nose or throat, or more rarely both, met with, and which can be partially estimated from Table A, 13 to 16, it will be seen that had the total examinations been fewer or had the nose been left out of consideration, children would have been sooner, if not more frequently, pronounced "diphtheria-bacillus-free," though still infected.

The results given in Table A, Nos. 17 to 20, were compiled only then from cases in which during the course of isolation, in cultures taken at the same time from both throat and nose, it so happened that one place was free of both groups of diphtheria bacilli whilst the other contained one or other of the groups.

WHAT IS THE CAUSE OF THESE HIGH PERCENTAGES OF INFECTION?

The cause perhaps cannot be definitely arrived at, but certain factors which have influenced these almost startling results must not be lost sight of.

First—As stated on a former occasion in this particular institution in which the examinations were made, clinical diphtheria became endemic twelve years ago, and for the last four years has been gradually decreasing until during the whole course of the

examinations here recorded was entirely absent. The earlier cases were graver in type and death or "diphtheritic paralysis" occurred more frequently, but such cases have appeared occasionally, though more rarely, in the four years during which this laboratory has carried on investigations in the school.

When clinical cases have occurred, both groups of bacilli have been obtained from their throats, either alone, alternating or mixed, though it was the high percentage of infection in the throats of apparently healthy children which lead to this investigation.

Second—The mode of life in the institution, to which reference has already been made, must be considered, whereby many children are brought together, not as in an ordinary school from day to day, but during months, live together, play together, use toys in common, such as whistles, horns, mouthorgans, etc. In children such possibilities of infection cannot be obviated except by actual individual isolation.

Third—The frequency of the examinations made would, of course, increase the possibility of finding the bacilli even in throats when it is considered that, even in clinical cases, the bacilli are occasionally overlooked.

Fourth—The taking of nose cultures throughout would have the same effect, since the diphtheria bacillus was found here more often than in the throat.

Fifth—The constant supervision of a bacteriologist and the extreme care taken by those who made the cultures, who had been especially trained in this for the preceding three years, during which nearly 3,000 examinations had been made, must also be remembered.

Sixth—The situation of the laboratory in the isolation building, with the resulting absence, of necessity, of errors due to transmission of specimens, and the use of perfectly fresh and proper culture medium (as is not the case where specimens have to be collected and forwarded to the laboratory by physicians), are perhaps important.

SUGGESTIONS CONCERNING THE FREEDOM OF THE CHILDREN FROM SORE THROATS AND OTHER SYMPTOMS WHILST SUCH INFECTION PREVAILED.

First—The virulence of diphtheria has been decreasing, so far as can be ascertained, not only in this institution, but throughout the state, during the last ten years.

The type of diphtheria bacillus (D^2), which is most frequently found in the noses and throats of the children in this school, seems to occur rarely in other portions of the state, although it is sometimes met with. Non-granular types of diphtheria-like microbes (E^2, G^2), nearly approximating to it, are very frequent in school children selected haphazard, and particularly so in the child inmates of another somewhat similar institution. (It may be mentioned incidentally that on several occasions from 50 to 100 synchronous throat and nose cultures have given somewhat surprising results in the percentage of typical granular and irregularly staining diphtheria bacilli found, whilst the evenly staining varieties are still more numerous. Many of these cultures have been isolated in purity and are under investigation, and some of them furnish the cultures and the microscopic specimens on exhibition.)

The comparative stability in morphology, staining reaction, etc., of twenty-four-hour serum cultures of this (D^2) most common bacillus met with in the children, both before and during isolation, would seem to establish it as a type so far as these characteristics are concerned. These points are important since diagnoses are usually made in laboratories under certain fixed conditions as regards age of culture, kind of medium and method of staining.

It would seem to have less virulence for children, though not devoid of it, as shown in a former communication. (The characteristics of this type have been dwelt upon and proofs of its position amongst types of diphtheria bacilli advanced.) Whether this low degree of virulence for children is as stable a quality as its morphology or not can only be conjectured, and the latter cannot be urged as a proof of the former, though perhaps worthy of some consideration.

Is it not possible that this microbe has become and now remains attenuated through long residence in the throats of the children?

May it not thus immunize them against the other, perhaps for them, though not always for animals, more virulent forms of B. diphtheriæ? Certainly, as was shown in a former paper, it has the capacity of immunizing laboratory animals against virulent well recognized types of B. diphtheriæ from clinical cases.

Formerly, when clinical cases were more numerous, it was observed that the children who had come recently to the school were more susceptible to sore throats or even marked clinical diphtheria.

The almost universal infection which exists now may have long

continued, with this difference, that the bacilli now, through long residence in quasi-normal throats or noses, have been reduced in virulence, with the result that typical clinical cases have become less and less frequent.

* * * * * * * *

NOTE.—As originally presented this paper was illustrated by numerous stained microscopic specimens, parallel cultures on all the ordinary and sugar-containing media, and water color sketches of each of the types described above.

Observations on morphology, biology and pathogenesis of twenty-four type cultures were given in extended tables.

Through a misunderstanding no provision was made for the publication of the plates and tables in this report, and as a consequence deductions therefrom have also been omitted. This is to be regretted, since the chief object of the paper was to furnish a working classification, though purely arbitrary and incomplete as yet, which might be of assistance in recording parallel observations in other laboratories. It is hoped that it may be found possible to present these with later observations at an early date.

THE BACTERIOLOGICAL DIAGNOSIS OF DIPHTHERIA IN MINNESOTA.*

BY F. F. WESBROOK, M. D.,

Director of the Minnesota State Board of Health Bacteriological Laboratory, and Professor of Pathology and Bacteriology, University of Minnesota, Minneapolis.

A laboratory in connection with the Minnesota State Board of Health in which, amongst other things, the bacteriological diagnosis of diphtheria was undertaken throughout the state, was first established by Dr. C. N. Hewitt, late secretary of the board. The work so ably begun by him in October, 1894, has been continued and systematized so far as possible since the permanent official establishment of the laboratory in January, 1896.

At this time the New York City Board of Health, by its magnificent pioneer work, had already demonstrated the advantages of such a laboratory in city health work, particularly in relation to the question of quarantine in diphtheria, and already many of the large cities of America had followed its example, but the application of such a method to a large state was a new and unknown

*Presented as a part of the Quarterly Report from the Laboratory at the quarterly meeting of the Minnesota State Board of Health, held Jan. 9, 1900. Read before Minnesota Academy of Medicine and published in St. Paul Medical Journal April and May, 1900.

territory, which Minnesota was one of the first, if not actually the first, to explore.

The St. Paul City Board of Health in July, 1896, and the Minneapolis City Board of Health in February, 1898, established laboratories of their own, which left the State Board of Health responsible for the work over the rest of the state. The relief to the State Board laboratory was appreciable and extremely grateful at that period of its development when no special pecuniary provision had been made for its establishment and maintenance. Since then the three laboratories, situated so close together, have frequently been able to collaborate and to be of mutual assistance.

Unnecessary it is at this date to go into the question of the value of data afforded by bacteriological examination in cases of suspected diphtheria as it would be to discuss the therapeutic worth of diphtheria antitoxin. It goes without saying that if the diphtheria bacillus is the cause of diphtheria, the presence or absence of this bacillus in any case should constitute the sole reason for imposition of, or release from, quarantine.

The application of this method and the laboratory work connected therewith in city health work has been long before the medical profession. It is the employment of such methods in the outlying town and country districts, its present great and future greater utility in the protection of the public health of these districts and some of the factors which influence these considerations which I wish to set forth as shortly as possible. In other words, I wish to consider some of the problems which must be met in an endeavor to make this method of the greatest possible use throughout the whole of this large state. It must be remembered that they are given from the point of view of the laboratory and in the hope that where anything seems impracticable from the standpoint of a practitioner some modification or suggestion will be forthcoming whereby the difficulty may be removed.

As under the present arrangement specimens are sent from all parts of the state to the laboratory of the State Board of Health it may be advisable, first of all, to consider (a) through whom they may be sent; (b) the present status of the health officer; (c) possible causes of delay in affording diagnosis.

THROUGH WHOM SHALL THE LABORATORY RECEIVE SPECIMENS?

As the State Board of Health stands in an advisory relation to the local boards, it would seem to be proper that all its operations

should be through the local health officer. In the matters of securing the materials for transmission (serum culture media, sterile swabs, data blanks, etc.), the satisfactory following of directions and utilization of a laboratory report in cases of diphtheria, an intelligent and careful physician is a "sine qua non." Of the 1,700 local health officers of this state only about 200 are physicians. Furthermore, in districts of any extent it has seemed a needless waste of time to compel the attending physician to go a long distance to procure from and return to the health officer boxes for the transmission of specimens. It has therefore been the custom to deal directly with the attending physician where no objection was raised by the local board of health. Of course, in all cases copies of the laboratory report are furnished the local health officer.

It sometimes happens that local differences arise and a lack of confidence in the capacity or honesty of the attending physician is betrayed by the health officer, or vice versa. It has seemed impossible up to the present to make any arbitrary arrangement, though it would appear to be to the best interests of all concerned to limit operations to the health officer of each district if it were possible.

Health Officers: It must be said that the health officers throughout Minnesota are showing an ever increasing interest in and capacity for that part of their work which relates to the scientific diagnosis and prevention of infectious disease. The experience of having a health officer enclose a piece of diphtheria membrane dried upon paper in an envelope, with a letter requesting a diagnosis is fortunately of rare occurrence. Many of these officers, by diligent study and close attention to minute details in addition to, or often in spite of, the lack of previous special training, have acquired a good working knowledge of the principles involved in dealing with the prevention of infectious disease. It is not, however, so in every case, nor can any criticism be made when it is considered that there is almost total lack of compensation for a work which must always mean the expenditure of some time and energy, and which may, without warning, suddenly demand the health officer's whole time and attention. Though it is not desirable in this communication to go deeply into the question of the best means of securing the best possible health officers, perhaps a few points might be touched upon with propriety.

Certain state or provincial boards of health in America have already made efforts to afford by means of their laboratories some training to their local health officers by giving somewhat informal

courses of instruction. That these have not been completely successful, though of undoubted value in showing the possibilities in the case is evidenced by the appointment of a committee of the American Public Health Association to further opportunities for such instruction. Nothing very definite has yet been done, but it would appear that the effort may culminate in asking the leading universities in the various states of America and provinces of Canada to establish special courses of instruction for health officers, and to grant special degrees after the completion of such courses upon passing satisfactory examination. This arrangement has been in existence in England for some years, and local health officers are compelled to be thus qualified, whilst in Germany conditions are somewhat similar.

The inapplicability of this method to this state is apparent under present conditions, but the question naturally arises, could not these conditions be so modified as to permit of its adoption?

The enlargement of the present district arrangement, with the provision of a stipend sufficient to induce good men to apply, would certainly appear to be a step in the right direction. A good man would naturally wish to know as much as possible about his work, and would seize the opportunity of taking any special instruction afforded. Whether instruction or examination, or both, should be in the hands of the leading universities, or whether the State Board of Health should be left to determine the fitness of candidates, is a matter for careful consideration.

CAUSES OF DELAY IN REPORTING UPON SPECIMENS.

As stated in the circular of information issued by the laboratory all specimens received during one day are examined and reported on the following morning.

It sometimes happens, though such is infrequent, that where, from any cause development of a culture is inhibited and a definite report is withheld, examination on the following day may afford data for a report. This means a delay of some hours, but is still more expeditious than to await the arrival of another specimen, which is always requested when on examination of the specimens for the day any of them shows scant or no growth.

All other causes of delay are due to delay in transmission of specimens dependent mostly upon lethargy or indifference of express companies. Sundays and holidays interfere, because upon these days express companies do not deliver, though whatever is

received on the day preceding is always examined and reported as usual. Christmas week is productive of much delay, misunderstanding and annoyance. The American Public Health Association has again appointed a committee whose duty it will be to make recommendations to be used as a basis for proposed legislative action in the United States, Canada and Mexico looking towards the freer use of the mails for the forwarding of such specimens. The mails may now be used, but compliance with the existing regulations is impossible, or at least so inconvenient as to be impracticable.

THE UTILITY OF SUCH BACTERIOLOGICAL EXAMINATIONS.

Diagnosis, as affording a rational basis of treatment, to be of value in diphtheria, must be immediate, and perhaps in neither city nor state work can reports be made with sufficient speed to be of much service in this particular. Physicians recognize and understand this and have learned to depend upon clinical observation as a guide to the use of antitoxin, etc. They are learning to isolate patients until it can be determined whether bacillus diphtheriæ is present or not and in most cases realize that it is the presence or absence of such bacilli which renders the patient dangerous or not to those with whom he may be brought in contact.

In considering the utility of the bacteriological diagnosis of diphtheria there are several important factors which must not be lost sight of.

I. *The possibility of not demonstrating bacillus diphtheriae when present.* This needs no very serious consideration, since it probably very rarely happens, even in laryngeal diphtheria, when the directions for the collection and transmission of specimens are closely followed.

Mistakes may be made as a result of oversight or design on the part of the person collecting the specimens for examination, and results are more largely dependent on the honesty of the health officer or physician than at first appears.

It is perhaps possible to take a culture from a throat in which diphtheria bacilli are present without obtaining any of the specific organisms. Failures to comply with directions may often be indicated by some feature of the laboratory findings. These may be corrected or guarded against with the loss of very little time.

The very conservative method followed in the examinations in this state of asking for new specimens and withholding negative

diagnoses whenever (a) specimens are sent in any other way than by means of the boxes provided, or (b) cultures show scant or no growth upon incubation, has been of great value. In the onset of disease the isolation of the patient for one or two days longer, pending another examination, is to be preferred to permitting infection of others. In specimens from such cases the lapse of more than twenty-four hours between receipt and report upon them is never permitted.

II. *The various forms of bacillus diphtheriae met with.* Perhaps no such opportunities for the study of the problem which the variability in morphology of bacillus diphtheriæ presents have occurred as in the work in this state. Early in the investigations undertaken by the State Board of Health at the State Public School at Owatonna the finding of a variety of bacillus diphtheriæ which until then* had been overlooked or described as the pseudodiphtheria bacillus, led to closer investigation of this question, and particularly during the last year when the routine work has permitted of it, all available time has been devoted to laboratory study.

A portion of the results was presented to the American Public Health Association in October, 1899, and will shortly appear in the journal of the association.** The material presented has included:

1. The tabulation of the forms of bacilli found in the course of over 5,000 examinations of the noses and throats of 263 children in the State Public School at Owatonna during their complete individual isolation. (This work was done more than a year ago by Dr. O. McDaniel.)

2. The various forms of bacillus diphtheriæ met with in and isolated in purity from:

(a) Ordinary routine examinations of clinical cases.

(b) Earlier clinical cases at the State Public School, Owatonna.

(c) The throats or noses of healthy children at the State Public School at Owatonna, the School for the Feeble Minded at Faribault and certain other town public schools throughout the state.

Each form met with has been accurately sketched to scale in colors, and has received temporarily a letter to distinguish it and render tabulation and record easy. The difficulties of description and varying ideas of types of bacilli met with in this work have

*"A Preliminary Communication on Bacillus Diphtheriæ and Its Variants in a School in Which Diphtheria Was Endemic." Read before the British Medical Association, Montreal, 1897.

**"Studies on the Distribution of Certain Varieties of the Diphtheria Bacillus." (Wesbrook, Wilson and McDaniel.)

necessitated the adoption of some such temporary and purely arbitrary nomenclature. Since its adoption the types of bacilli met with in all examinations have been recorded by this means, and it is hoped that the value of any data so obtained may be enhanced by the adoption of this or some other similar method by other laboratories so that a general comparison of results may be possible. Such a study of routine clinical cases and continued investigation of the throats and noses of healthy school children, both in districts which at the time are or recently have been infected, and also those which are and have been free of diphtheria, should undoubtedly soon lead to some definite knowledge as to the dividing line between diphtheria and diphtheria-like bacilli. Cultural, staining, pathogenic and other characteristics have been and are being studied in connection with morphology. In the meantime certain of these forms are beyond question, and as it is these which are most often met with in the throats of clinical cases of diphtheria, there is no difficulty in making diagnoses.

The initial mixture of these "typical" forms with "atypical" forms of the bacilli or the occasional occurrence of the "atypical" in nearly pure culture later in clinical cases offers no difficulties to diagnosis. Where specimens are forwarded for the first examination they are always, or with few exceptions, from clinical cases. Where the "atypical" forms are met with, even though no "typical" forms may be present on the first examination, they are usually discoverable during the later stages of the disease, so that a first report of the presence of "suspicious bacilli" is often followed by a positive diagnosis. Where suspicious (atypical) bacilli alone are found on the first examination and later examination fails to show the "typical" forms, a negative report is given. This may be said to happen but rarely.

III. *The occurrence of bacillus diphtheriae in the throats and noses of the apparently healthy.* This possibility has been known for years, but a better opportunity for its study than that afforded at Owatonna could not well be imagined. In the tables presented before the American Public Health Association of the 263 children placed in complete individual isolation, 59 had at some time during the investigation diphtheria bacilli in their throats and 70 had them in the nose. It must be remembered that these numbers indicate only those children in whom the bacilli were of such a type as to admit of no doubt as to their nature on the part of the most conservative bacteriologist. The "atypical" forms under

study are included in another group altogether, and for the purposes of this paper and in questions relative to quarantine are here eliminated. This is only right until something more definite in regard to the dividing line can be established. No such condition as that met with at Owatonna has been encountered in any other place in this state. This may be largely owing to the fact that no such thorough investigation has been made elsewhere in the state. It is worthy of interest that within a few days a letter has been received from Dr. C. V. Chapin, superintendent of health of Providence, R. I., who states that he has there discovered two institutions where the conditions are similar. The inmates of one of the institutions are infected with "typical" and of the other with "atypical" forms of bacillus diphtheriæ, whilst the general health is good in both. The inability to rid the inmates of these bacilli led Dr. Chapin to enquire whether there had been any recent occurrence of clinical diphtheria at Owatonna, as he knew that it had been impossible to rid that school of the bacilli. It is fortunate that such conditions seem to be rare, and it may perhaps be stated as a general proposition that those "typical" forms of diphtheria bacillus (found ordinarily in cases of clinical diphtheria) when encountered in seemingly healthy throats are found in other members of a family in which diphtheria has occurred, or, at least, usually in those who may have come in contact with diphtheria cases.

It is to the elucidation of such points as these that the work of the State Board Laboratory is at present directed, and so perhaps no such definite statement as the above can yet be made.

IV. *Occasional long persistence of bacillus diphtheriae.* Attention is ordinarily directed to those cases which show the persistence of bacillus diphtheriæ for a longer time than that usually specified as necessary for quarantine where an arbitrary time limit is imposed. Whilst we may look to the boards of health of large cities, where the surveillance of cases can be more easily maintained, for statistics as to persistence of bacillus diphtheriæ after the subsidence of clinical symptoms, in this state the statistics of the state will be of most value.

Attempts have been made for some time past to determine the average time of persistence of the bacilli after the disappearance of symptoms or from the beginning of the disease. It was found, however, that very few of those who availed themselves of the work of the state laboratory continued to send specimens until the throats were pronounced free of bacilli.

During the year 1899 only eighty-seven cases of clinical diphtheria, from which specimens at some time showed the presence of bacillus diphtheriæ, were held in quarantine until negative reports from the laboratory were made on subsequent specimens.

An analysis of the earliest day on which a negative report was made on each of these cases shows the following:*

The bacilli disappeared from the throats:

In 17 cases before the 14th day of the disease.

In 27 cases between the 14th and 21st day of the disease.

In 22 cases between the 21st and 28th day of the disease.

In 10 cases between the 28th and 35th day of the disease.

In 12 cases after the 35th day of the disease.

It will thus be seen that half of the cases were released from quarantine in three weeks or less, while only one-quarter of the cases were held in quarantine more than four weeks. The marked advantage to the majority of patients of the establishment of bacteriological diagnosis for release from quarantine is thus clearly shown. Not less strikingly illustrated is the necessity for reliance on the same method in the rational maintenance of quarantine in the few cases in which the bacilli persist for more than the usual quarantine time limit. In fact, it would appear from the limited number of cases upon which the laboratory has been able to obtain data that the chief, if not the only, advantage of a time limit for release from quarantine, is its convenience to the health officers.

Of all the other cases diagnosed as diphtheria by the laboratory during 1899, nothing can be learned from the records of how quarantine was regulated and when it was probably released.

Fortunately such cases as the one to which reference has been made in earlier reports of this laboratory, and which seems to have been the most marked yet reported by any one (bacillus diphtheriæ persisted for over nineteen months) are rare. This case occurred at Owatonna at a time when the specimens were sent to this laboratory for diagnosis and no provision was made against reinfection of the throat of the patient from others with whom he was associated between the sending of the specimen and the receipt of the report upon it. Under these abnormal conditions such a case may perhaps be with justice excluded from statistics.

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*It may be stated that the average length of time of persistence of diphtheria bacilli in these throats was twenty-nine days, which is the same as that of the laboratory of the Board of Health of Philadelphia.

But even in this case in thirty-four days, and in others situated under similar conditions, in a comparatively short time it was found possible to rid the throats and noses of the bacilli when the problem was attacked rationally and individual isolation secured.

V. *The removal of bacillus diphtheriae from noses and throats.* Perhaps no greater test of the possibility of complete eradication of bacillus diphtheriæ from the throats and noses of those in whom it had for a long time persisted can be asked than that applied at Owatonna.

Here it must be remembered that bacillus diphtheriæ had been found present in a very large percentage of the children for over two years, and prior to that for a period of about ten years diphtheria and sore throat were endemic.

In addition to the complete individual isolation described in the last biennial report of the State Board of Health, the noses and throats were usually sprayed with an alkaline slightly antiseptic solution followed by 0.5 per cent formalin solution thrice daily. That point which seems to have been most impressed upon Doctors Adair and McDaniel is the necessity of beginning by treating the nose and keeping it clean. The nose was found most frequently infected, and, even with this treatment, remained infected longer than the throat. Probably the secretions of the nose constantly reinfect the throat where treatment is directed solely to the latter. It is hoped that Doctors Adair and McDaniel will be able to present an analysis of this work from the clinical standpoint ere long. It will certainly be of great value and interest.

The freedom of the noses and throats of the children from bacillus diphtheriæ and every microbe which in any respect resembled it was determined by three successive negative results of examination of both nose and throat (six successive negatives in all). The average length of time taken to eradicate bacillus diphtheriæ and every suspicious form from both nose and throat in 178 children was fourteen days.

The following table will give some more definite idea of these results:

58 of the children yielded to treatment in the first week (these included 16 who had yielded to one day's treatment).
50 yielded to treatment in the second week.
24 yielded to treatment in the third week.
19 yielded to treatment in the fourth week.
18 yielded to treatment in the fifth week.
4 yielded to treatment in the sixth week.
3 yielded to treatment in the seventh week.
2 yielded to treatment in the eighth week.

178 total.

At the close of the investigation 5 children who had been under observation and treatment for from 9 to 64 days had not yet been pronounced free from bacilli.

The thoroughness of the test applied and the initial difficulties presented in dealing with those who had become habituated to the presence of bacillus diphtheriæ would seem to add to the value of these results and indicate the possibility of a great reduction of the time of persistence of bacillus diphtheriæ after the subsidence of symptoms in the course of ordinary clinical cases provided careful treatment is employed.

It may be mentioned that in many of the children where difficulty in eradicating the bacilli was experienced, chronic catarrh was present. This was more particularly noticeable in the noses.

VI. *Standard of virulence of bacillus diphtheriac.* When an individual has a sore throat, even in the absence of all other clinical symptoms of diphtheria, it is fair to presume for public health purposes that if bacillus diphtheriæ is present it is virulent. But where the bacilli are present, either in people in whom no symptoms have ever been present, or when clinical symptoms, though present at first, have abated and the health has been normal for some time, what proof can be obtained of the pathogenic character of the germs present?

The isolation of the bacilli in pure culture under these conditions and their inoculation into guinea pigs is the only available method and is the one adopted generally in all laboratories. This is not ideal, nor is the establishment of the virulence of such microbes for animals positive proof that they may be harmful to man. As a matter of fact, many of the bacilli isolated from healthy people are pathogenic for guinea pigs. Conversely it does not prove that because a diphtheria bacillus (which has no patho-

genesis for an animal) is obtained from the throat of a convalescent it would be equally harmless to some other human being.

VII. *Relation of bacteriological findings to quarantine.* As we have seen in the foregoing portion of this paper, diphtheria bacilli are found under the following conditions:

(a) In cases of clinical diphtheria.

(b) Frequently in the apparently healthy members of the families in which diphtheria is present, or in those brought in contact with clinical cases.

(c) Occasionally in those who have not been recently exposed to diphtheria so far as can be learned. This has been found to be most frequent in school children or where children are brought together in large groups and perhaps implies a recent though untraceable exposure. In these cases, so far at least as the experience of this laboratory goes, the bacilli most frequently found are not of the type that are generaly recognized as B. diphtheriæ.

It is obvious that in establishing quarantine regulations care must be taken to see that it is possible to carry them out and that they are not of such a nature as to cause physicians and the public at large to wish to evade them. They must therefore be rational; but, as in all public measures, it becomes necessary that the few be inconvenienced for the good of the many. Therefore let the inconvenienced few be as small a number as possible, provided the protection afforded the many be not jeopardized.

As before stated in making the following suggestions for the regulation of quarantine it is chiefly from the laboratory point of view and with the knowledge that they must be made practicable from the point of view of those who would be affected by them.

It is therefore with the hope that they may be the means of interesting physicians, particularly in Minnesota, with the result that some system may be arrived at which will be at the same time accurate in the location of foci of infection, effective in preventing the direct or indirect spread of diphtheria from them, and withal of such a nature that its application will not impose unnecessary trouble, expense or loss of time upon private individuals, institutions, physicians or health boards.

SUGGESTIONS FOR THE REGULATION OF THE QUARANTINE OF DIPHTHERIA.

A. *Imposition of quarantine.*

1. All cases of undoubted clinical diphtheria the attending physician shall immediately report to the local health officer, who shall establish quarantine and placard the house.

(This should mean that all residents of the house in which the case has occurred who have come in contact with the case shall not be permitted to leave the house unless they have complied with the conditions noted below under B. 2.

Quarantine should begin as soon as the physician gives his diagnosis, i. e., even before the placard is posted.

The selection of trained and efficient health officers is imperative.)

2. In all cases of sore throat or other disease which in his opinion might possibly be diphtheria, it shall be the duty of the attending physician to secure, through his health officer, outfits for the transmission of cultures to the laboratory of the State Board of Health. By means of these, cultures must be taken from the site of the disease and sent with full data to the laboratory.

(This does not apply to St. Paul and Minneapolis, where the local boards of health are provided with their own laboratories. Throughout the rest of the state, as the boards of health provide themselves with laboratories and competent laboratory men, the services of the State Board of Health can be dispensed with.

Under the above conditions the personality of the physician will of course be an important factor since ideas of what cases may possibly be due to diphtheria infection vary.

It seems desirable to bring the physician into collaboration with the health officer as early as possible and to encourage him to begin his effort at exact diagnosis as soon as he sees the case. The best clinicians and authorities upon diagnosis not only freely admit but insist that it is often impossible to distinguish diphtheria infection from that due to other causes. The honest expression of doubt therefore on the first visit of a physician to such cases is creditable rather than the reverse. No time need be lost in the administration of antitoxin when its use is indicated.

Should the bacteriological report show the absence of diphtheria bacilli no harm will have been done.

Health officers should keep a record of the outfits supplied to physicians and of the cases for which they are to be used. They should know from the physician immediately that a suspicious case exists and where it is and not be forced to depend upon their copy of the laboratory report for their first information.)

3. During the time between the sending of the specimen and the receipt of the report, strict isolation of the patient must be maintained.

(It seems better here to secure isolation or unofficial quarantine

under the direction of the physician than to establish official quarantine immediately. The health officer already, by provision of the previous paragraph, knows of the existence of suspicious disease and is available for suggestions. He should perhaps be supplied with a circular of general instructions regarding "preliminary isolation" and "quarantine" for distribution to physicians and some general information regarding diphtheria for the householders. These should be issued by the State Board of Health.

The patient need not be isolated long, for it is hoped that even less time will be necessary to secure a diagnosis in the future than in the past when the requisite changes in the "Postal Regulations" are secured. There is no hardship in the isolation of such cases at this stage of the disease.)

4. Upon the report of the presence of bacillus diphtheriæ by the laboratory the house must be quarantined and notice posted.

(This paragraph should be construed to mean that the health officer is now responsible for the protection of the public. He should be furnished by the attending physician with a report of the arrangements made for quarantine, which must necessarily differ in each case. Failure on the part of the physician to furnish such a satisfactory report should be followed by the taking of the case from him by the health officer, who should now take entire charge of the case except in so far as treatment is concerned.

Whilst in city work, in certain, if not all cases, it may be preferable for the local board of health to assume entire charge of cases which have been reported as diphtheria, it is not practicable in the country districts and smaller towns where public isolation hospitals are not available.

As the health board must be dependent, to a greater or less extent, upon the physician's ability to detect diphtheria and honesty so far as reporting it are concerned, it is certainly desirable to permit him to remain in charge. This will be more satisfactory to both patients and physicians.

Whether it is safe to make the physician entirely responsible (if he wishes to assume such responsibility) for the quarantine and care of the cases, so far as danger of contagion is concerned, is problematical.

In Chicago this is done and the houses of such cases are not placarded. It is often the case that those most ready are least qualified to assume responsibility.)

5. It shall be the duty of the attending physician to report to

his local health officer the names and addresses of those known to him to have been exposed to infection through known clinical diphtheria.

6. It shall be the duty of the local health officer to take and forward specimens or to see that the attending physician takes and forwards specimens from those reported to him to have been directly exposed to known clinical diphtheria, should they show any evidence of sore throat or other disease possibly due to diphtheria infection, and, pending a report, to see that isolation is maintained.

7. It shall furthermore be the duty of the health officer to place in quarantine those who, after exposure to cases of clinical diphtheria, develope sore throats (even of the mildest types) or any other evidence of diphtheria infection if they have been shown to be infected with bacillus diphtheriæ.

(These paragraphs provide for the report by the attending physician of all persons who have come in contact with the patient during his illness previous to his isolation, and the supervision of such persons by the health officer. It might perhaps be better to require the health officer immediately upon the receipt of the laboratory report to go himself and ascertain from the family the names of those who have been exposed to infection, but the endeavor has been made throughout to make the physician responsible as far as is compatible with efficacious measures. This throws a great deal of work upon the health officer for which provision should be made in his selection and remuneration.

So far as the principle is concerned, we must not forget that in smallpox, in some places, those who have been exposed to infection are isolated until after the expiration of the period of incubation. Even in dealing with glanders, where the value of the lives at stake cannot be compared to those of human beings, in some states it is customary to test all horses which have been exposed to infection, and, if a reaction is obtained, to destroy them. It would be ideal to examine the throats of all people who had been exposed to clinical diphtheria, and if they were found to contain bacilli to place such persons in quarantine. In the present paragraph they may escape even examination unless some symptom (however slight) points to a possible infection, and are not quarantined unless found to be infected. This is less onerous for the physician, health officer and public.)

B. *Release of quarantine.*

1. Quarantine shall be released in those houses in which diph-

theria has been diagnosed when synchronous cultures taken from the nose and throat of each person quarantined have been pronounced by the State Board of Health Laboratory to be free of diphtheria bacilli.

(In some cities (e. g. Boston) for the release of quarantine two successive negative reports of cultures are necessary. They must be taken on different days. In Minnesota this is at present required when quarantine is regulated by bacteriological findings. A time limit is permitted, however, as an option. In Boston the culture for the second negative report must be made by an officer of the board of health. Where the first symptoms were throat symptoms, the two successive negatives must come from the throat. If symptoms pointed to nasal diphtheria and the bacilli were found in the nose, the release specimens must be taken from the nose as well. Our experience would seem to make it tolerably safe to depend upon synchronous nose and throat cultures in all cases, though it would be safer to insist on two or three successive negative cultures from both nose and throat, but this means a great deal of time and trouble to all concerned. In a recent letter from Dr. Swarts, secretary of the State Board of Providence, R. I., he states that the board of control of the State Institute for the Deaf (one of the institutions previously mentioned) has adopted the method used by this laboratory at Owatonna, and insists upon three successive negatives from both nose and throat before release from quarantine. Dr. Hill, bacteriologist of the Boston City Board of Health, writes that for the release of all cases which come into the Boston City Hospital three successive negative reports of both nose and throat cultures from the hospital laboratory are demanded.

In general practice it would, however, be difficult and probably cause so much trouble as to lead to attempts at evasion of all accurate quarantine methods.)

2. Those living in a house in which diphtheria has been diagnosed and who desire to escape quarantine may do so on the receipt of a report from the State Board of Health Laboratory stating that cultures taken from their throats show the absence of diphtheria bacilli.

Between the taking of the specimens and the receipt of the report they must remain in isolation and before leaving the house take a complete bath and change all clothes. They must not return to the house until quarantine has been released.

(This paragraph permits of the escape of the wage earning members of a family or those persons lodging in a house where diphtheria is suspected. If diphtheria is suspected only and the persons afflicted have been ill only a short time, the members of the household desirous of escaping quarantine may go immediately, i. e., before a report is received from the laboratory. There is a possible danger here to which the physician should be alive. He will, however, report the names and new addresses of such people to the health officer (see above A 5), who shall keep such persons under observation, and should they develope even slight symptoms they are provided for (see above A 6 and 7).

Should the case be, however, highly suspicious, and if any of those who desire to escape quarantine have been much exposed to such possible infection, the physician can and should on his own clinical diagnosis have immediate quarantine established (see above A 1).

Then after the establishment of quarantine, whether on clinical grounds or laboratory diagnosis, should wage earners or others desire to go outside the quarantined house they may do so when it is shown that their throats are free from diphtheria bacilli on laboratory findings. It should be insisted upon, however, that such people remain isolated pending a laboratory report, since otherwise they might become infected later, though free of bacilli at the time of the taking of the cultures. In other words, when cultures are taken from a number of people who have been exposed to diphtheria by reason of the occurrence of the disease in their household, some may be infected and others not, and between the taking of the cultures and the report upon them the possibility of the infection of the uninfected from the infected is to be obviated by isolation.)

3. After the diagnosis of diphtheria has been made it shall be the duty of the health officer to see that specimens from both nose and throat of the patient are forwarded by himself or the attending physician at least once every week after clinical symptoms have subsided until negative reports are obtained.

4. Where the diphtheria bacillus persists for more than three weeks after the disappearance of all general and local symptoms, on the request of the health officer, the bacillus will be isolated in pure culture and its virulence tested upon guinea pigs. If the bacillus is not found virulent quarantine will be released. As this will take from five to ten days it is urged that other specimens be sent to the laboratory during this period, since they may show

the absence of all diphtheria bacilli before the completion of the animal experiments.

The following hints may be useful in securing an early eradication of B. diphtheriæ from infected persons:

(a) Even in severe cases where antitoxin has been used it frequently happens that diphtheria bacilli disappear rapidly.

(b) During convalesence of patients complete individual isolation, which does not permit of possible reinfection from patient to patient or from contaminated clothing, bedding or other articles to the patient, is of value.

(c) The use of some mild alkaline spray as a cleansing agent, followed by some safe disinfectant (e. g. $\frac{1}{2}$ of 1 per cent formalin) in nose, mouth and throat is to be recommended.

It is important to thoroughly cleanse and disinfect the nose as well as the throat.

(d) The frequent sending of cultures is to be recommended, as the disappearance of diphtheria bacilli may be sudden.

(Where quarantine has been established on clinical grounds alone it may happen that the laboratory, even on the first examination, may report the absence of diphtheria bacilli. This should not be misinterpreted by any one. It does not reflect upon the physician in any sense. because no one can be undoubtedly sure, and by waiting for later clinical developments many chances for the spread of the disease may be permitted. Furthermore, it is quite possible that diphtheria bacilli may have been present when quarantine was established, though not to be found at the time of first examination.

It is probable that recourse to the test of pathogenesis of the bacilli will not often be required if strict attention be given to the details of isolation, treatment, etc. In cases of long persistence of the bacillus it will be wise to try to convince the household of the danger indicated by the presence of the bacillus and to secure its intelligent co-operation in attempting its elimination. The value of the data furnished by the animal test of pathogenesis is questionable; and, furthermore, since virulence of the bacilli is demonstrated by the symptoms in the patient, even though the test of animal inoculation could be relied upon to show that such virulence had been lost or diminished, our knowledge of the factors controlling changes in pathogenesis of bacteria is still insufficient to afford a sense of security so long as the bacilli are present at all.)

No attempts have been made in this paper to discuss general

methods of quarantine or disinfection, though it is evident that the character of the bacillus and its usual points of location must be considered in dealing with diphtheria.

So far as known, B. diphtheriæ does not multiply outside of the animal host to any marked extent. Drying does not kill it, though many authorities give somewhat wrong impressions of its powers of resistance to desiccation under ordinary conditions. Every laboratory worker knows that B. diphtheriæ will readily die out in dried cultures.

In the laboratory of the Minnesota State Board of Health many examples of inability to secure cultures of B. diphtheriæ from swabs made only a few hours before have occurred. This has been the case when cultures made at the bedside by the physician at the same time and later in the disease have shown a good development of B. diphtheriæ.

There are too many proofs of the possibility of carrying bacillus diphtheriæ by clothing, etc., to doubt its occurrence, though the possibility of infection declines as desiccation is prolonged. It seems much more probable, in consideration of the fact that bacillus diphtheriæ can, and sometimes does, persist in human beings and animals for a long time after the subsidence of clinical symptoms or without producing any noticeable symptoms at all, that living beings are more frequently responsible for infection.

In watching children at play it does not take long to be convinced of the almost innumerable opportunities afforded for the exchange of the bacterial flora of mouths and noses. Diphtheria infection increases as a rule when the children come together in masses at school in the autumn or during the period when they are compelled to remain for a greater proportion of their time in the house. The use of common school supplies and the exchange of out-door for in-door amusements are also important.

Concerning schools and their management relative to protection against diphtheria much can and should be done through provision by the school boards for a supervision of the general health of the pupils, investigation of cause of unexplained absence, or absence due to disease, and the exercise of extreme care in the readmission of those who are convalescent from diphtheria.

In Boston the schools refuse readmission for a further period of two weeks after the absence of diphtheria bacilli has been demonstrated by two successive negative reports. School health is a question, however, which deserves special and separate consideration.

Whilst the possibility of throat to throat infection is very apparent, other channels of infection (direct or indirect) should not be lost sight of nor their importance underestimated.

The care of a diphtheria patient demands the same attention to details as an abdominal section, though it is not usual to place them in the same category. It should, however, be regarded as just as culpable to permit persons or articles which are possibly infected with diphtheria bacilli to come into contact with susceptible persons as it is to introduce a possibly unclean hand or dressing into an abdomen. Until this principle comes to be recognized public health will not advance as it should.

To destroy diphtheria bacillus is not difficult when its location is known. The introduction of formaldehyde has given us a reliable means of disinfection, but it requires knowledge of the principles involved, and success cannot be obtained without attention to details and the personal supervision of a medical expert.

When it is considered that so much knowledge of medical science is essential to the proper care of infectious disease, supervision of quarantine and disinfection, it is to be expected that the future will either evolve special consultants in this branch of medicine or that throughout this country more government, state and local positions will be created. The knowledge demanded and the good to be performed by such medical men are surely not less than that of the surgeon or consultant in medical diagnosis and treatment.

VARIETIES OF BACILLUS DIPHTHERIÆ.*

BY F. F. WESBROOK, M. D., LOUIS B. WILSON, M. D., AND O. McDANIEL, M. D.

(From the Laboratory of the Minnesota State Board of Health, Minneapolis, Minn.)

The great variability in morphology and staining reaction of bacillus diphtheriæ is perhaps its most striking characteristic. It is puzzling to the beginner, and to those with most experience brings an occasional feeling of discomfort where quarantine is dependent upon the report made. In the bacteriological examination of clinical cases, notwithstanding the extreme variation in

*Read before Association of American Physicians, Washington, May, 1900. Transactions of the Association, page 198, 1900.

the picture seen, there are usually certain well recognized forms which soon become familiar.

A complete description of the various factors taken into consideration by a bacteriologist in arriving at a diagnosis is almost an impossibility. Account is taken of size, relation of thickness to length, irregularity of shape and staining reaction, and relation of the bacilli to each other (i. e., arrangement).

These various points probably appeal to different laboratory workers with unequal force, and it is conceivable that one observer is willing to include certain bacterial forms as diphtheria bacilli because they show polar granules, whilst to another their departure from his recognized limits of shape, size or arrangement prevents such inclusion. Or, conversely, arrangement or relation of the bacilli to each other appeals so strongly to one person that he recognizes certain forms as diphtheria bacilli, which to another are of such a size, or shape, or display such staining characteristics as to be ineligible for such classification.

Whilst in routine initial examinations of clinical cases it is probable that the percentage of disagreement in diagnosis between people accustomed to such work is small, in later examinations of the same cases for release from quarantine and in the investigation of diphtheria-like micro-organisms derived from healthy throats, noses or other sources, there is room for greater diversity of opinion. In the former case, perhaps, there is the unconscious bias afforded by the presumption of a pathogenesis in the micro-organisms found. From the public health standpoint it seems justifiable, where diphtheria-like micro-organisms are found in a culture from a throat, nose or other site which shows some evidence of a pathological condition not incompatible with diphtheria infection, to assume that such bacilli are the cause of the morbid condition, and, furthermore, that they are possibly dangerous to other human beings as well as to those in whom they are found. In the other class of examinations where clinical symptoms, if present originally, have long since abated, or where evidences of diphtheria infection have been entirely wanting, there is opportunity for a great variety of opinion of which full advantage has been taken. A study of the literature of the subject will show that each different aspect of morphological and staining reaction has had its supporters as being all important, though the endeavor has been made to co-ordinate each of these aspects or groups of them with certain cultural, biochemical or pathogenic properties.

It is obvious that if in order to make certain diagnoses in doubtful cases there be required for each micro-organism a complete study of its characteristics in pure culture the acquirement of data must be extremely slow. Inability to investigate a very large series of cultures derived from a large number of people at the same time and under like conditions will preclude the early arrival at any definite general conclusions regarding such forms as diphtheria, pseudo-diphtheria, xerosis and other allied forms of bacilli.

This conflict of opinion as to the possibilities and methods of differentiation of bacillus diphtheriæ from allied or pseudo forms becomes daily more serious, since health boards are coming almost universally to depend for their guidance in restrictive and quarantine methods upon the data afforded by bacteriological examinations.

The experience of the laboratory of the Minnesota State Board of Health has been, if at all different from that of other laboratories, in degree rather than in kind so far as meeting with diphtheria and diphtheria-like bacilli in situations where they were unexpected. In 1896, upon the request of the authorities of the Minnesota State Public School for Dependent and Neglected Children, an investigation was begun to determine the cause of diphtheria and sore throat which had been more or less endemic for ten years. In that investigation it was found that the bacilli met with could be roughly divided into two classes, called in the preliminary report and earlier communications "typical" and "atypical" diphtheria bacilli.[1] The former were granular and irregular bacilli, such as would be commonly recognized by all bacteriologists as diphtheria bacilli. The latter were probably for the most part "Hoffmann's pseudo-diphtheria bacillus," though many cultures of this form derived from various sources were then and have since been proven to be virulent; and, further, it has been repeatedly shown that immunity to them is possible by the use of commercial diphtheria antitoxin.

Sometimes the bacilli were found mixed, both in clinical diphtheria and in seemingly healthy throats. Sometimes one class would appear to be present as the sole diphtheria-like organism, and sometimes the other. This was true of both clinical cases and

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1 British Medical Journal, April 16, 1898, "A Preliminary Communication on Bacillus Diphtheriæ and Its Variants in a School in Which Diphtheria Was Endemic." Transactions of the American Public Health Association, 1899, vol. xxv. "Studies on the Distribution of Certain Varieties of the Diphtheria Bacillus."

healthy children. Continued investigation developed the fact that at one time 75 per cent of the children (263) were infected in either nose or throat.

The "typical" bacilli were present in the nose in 38 per cent of all infected children, and in the throat in 30 per cent. The "atypical" forms were more numerous still. This was at a time when no clinical diphtheria had occurred for some months. The children were placed in complete individual isolation and treated in order to rid their throats and noses of all suspicious forms. This wide-spread infection was so striking that it seemed well to make investigations to determine whether like conditions could be found elsewhere in the state. Accordingly, within the last three years at various times the flora of the noses and throats has been examined in:

(a) The State Institution for the Feeble-minded some two or three months after a mild outbreak of sore throat.

(b) Various town and country day schools. In some instances diphtheria was present in the town or village at the time of the investigation. In others no history of possible diphtheria infection in that locality for a period varying from some months to years could be obtained.

(c) Bethany Home, Minneapolis, where women are received before and cared for during and for a period of at least a year after confinement. Here the child population is, of course, very young. At the time of the taking of the cultures (249) there were three cases of diphtheria in the home.

In these examinations there has been considerable variation in the percentage of infection with diphtheria-like bacilli. It may be mentioned in passing that, as a general rule, the noses are more frequently infected than throats with diphtheria-like bacilli, though the number of species of associated bacteria is less in noses than in throats. In "homes," where all the inmates are housed together, the percentage of infection is higher than in day schools. Where diphtheria has been recently, or is at the time prevailing, the percentage of infection of healthy individuals is higher than where such infection has been for a long time absent.

The ordinarily recognized forms of diphtheria bacilli are more frequently found in the throat than in the nose. The findings in the Maternity Home, where nurses, mothers and babies were all examined, were nearly the same as in the State Public School for Dependent and Neglected Children. Discussion of these results will be reserved for a future occasion.

Attempts have been made to secure pure cultures from as many such sources as possible for study, and at various times from 100 to 300 such cultures have been under investigation at once.

In the endeavor to obtain some definite idea as to the morphological, staining, cultural, biochemical and pathogenic properties of such large numbers of cultures, it will not appear strange that difficulties have been encountered which have augmented with the increase in material, and even more so by the accumulation of data derived from their study. At first, critical of the data afforded by other observers, in which it seemed absolutely impossible to systematize results so as to recognize and differentiate the various forms, we were not long in finding such extreme difficulty in getting an idea of whither our own work was tending that we were compelled to begin afresh. In recording the forms and staining reaction met with alone, it was found that carefully written records a few weeks or months old conveyed very little impression of the types of bacilli met with. Our original plan of subdivision into "typical" and "atypical" forms of diphtheria bacilli was found to be almost as far from sufficiently minute and accurate as had been the classification of other observers into "diphtheria," "pseudo-diphtheria," "xerosis," etc. We were forced some months ago to adopt some more accurate means of recording our observations on morphology. In the study of the morphology of pure cultures in most instances, especially where they have been derived from typical clinical cases of diphtheria, it is the exception to get even a moderate degree of uniformity in the general shape, size, staining reactions, etc., of the individual bacilli, whilst to get complete uniformity is not to be hoped for.

It seems impossible, without actually watching under the microscope the development of a colony from a single bacillus, to be certain that a culture has been derived from an individual micro-organism because of the strong tendency of the bacilli to cling together. It is, therefore, ordinarily impossible to know in any case whether the various forms met with in a pure (?) culture are derived from one or several parents. In all our studies pure (?) cultures were obtained by sowing a minute quantity of the first mixed culture from the throat, nose, etc., into broth, which was then vigorously shaken. From this immediate sowing was made upon Löffler's serum by careful "streaking out." From one of the most symmetrical of the resulting isolated colonies fresh broth was again inoculated and the shaking and "streaking out" re-

peated. This process was gone through with from three to fifty times during a period of from a few days to nearly three years. It is probable that some if not all of these cultures have sprung from individual bacilli.

At first it seemed possible by obtaining an accurate description and colored sketch of all the bacilli in each pure culture to arrive at a classification. Upon becoming gradually accustomed to close observation, and particularly when it came to sketching the forms. it was soon found that one or more forms might be common to several cultures whose general morphological characteristics seemed to be and were quite different. By general morphological characteristics is meant the general picture seen by a trained observer. In ordinary routine examinations the observer is influenced perhaps more than he always realizes by the presence of certain forms which meet his particular views in regard to type and may overlook or minimize the importance of other to him less well-known forms which may be present.

Attempts to classify types of bacilli on the appearance of microscopic fields of presumably pure cultures had to be abandoned, and, instead, we were compelled to adopt a classification based on the morphology of individual bacilli.

The reasons for this are obvious from the study of the tables of observations. The arrangement here presented is purely an arbitrary and provisional classification of the morphological types encountered. As made originally, the water-color sketches to which your attention is called[1] and which form the basis of the classification were made to scale (magnification of 20,000 diameters) from the pure cultures just mentioned. Within the last six months it has been found necessary to add new types as they came to be recognized by special training in the adaptation of this method of record to the tabulation of the results.

As the ordinary method of diagnosis of diphtheria is by the microscopic examination of twelve to twenty-four-hour Löffler's serum cultures which have been stained by Löffler's methylene-blue, these types have been sketched from cultures of this age stained by this method. The serum used was prepared in the ordinary way except that it contained 1.25 per cent glycerin and was both coagulated and sterilized in the autoclave.

The bacilli were measured accurately and sketched with the

1 From the water-color sketches exhibited at the meeting, Plates Nos. I. to VI. were reproduced. The reduction has been to ¼ scale, thus making the magnification as shown in the plates 5,000 diameters.

camera lucida. From these the water-color sketches were enlarged to scale, the details being filled in by direct microscopic study of individual bacilli.

GROUPS OF TYPES.

As will be seen in the sketches, the bacilli met with are divided not only according to size and shape, but into three main groups depending on their staining reactions.

Group I. *Granular Forms.* These show distinct spherical, ovoid or markedly rounding granules. These forms are represented by the plain letters A to G. In each variety except B the granules show metachromatism, i. e., take a reddish tint with fresh Löffler's methylene-blue. The granules are, as a rule, at one or both poles of the bacilli, though they may occur elsewhere also. The protoplasm of the bacilli not included in the granules varies in intensity of staining, though it is always lighter in color than, and usually in marked contrast to, the granules. In this group forms A to D inclusive are ordinarily recognized as bacillus diphtheriæ. Branching forms, when granular, should be here included, although not represented in the plates.

Group II. *Barred Forms.*—Here, as in the granular forms, the irregularity of the staining is the distinguishing characteristic. Bacilli belonging to this general class present a distinct barred appearance, as of an actual removal of segments of protoplasm. The darkly staining portions vary in the intensity of coloration in different bacilli of the same variety and even in the same bacillus. Their size and shape are variable, though, as a rule, not spherical nor ovoidal like the granules in Group I., and the color, whilst usually dark, does not suggest metachromatism.

The lighter places in many bacilli show a distinct though very faint blue coloration, whilst in other individuals the appearance is more like a string of irregular cocci or bacilli. The relative size of the dark and light areas is also variable. The number of the dark segments varies from three to nine. Often in the bacillus composed of three segments one light band occurs near the middle, dividing it into two nearly equal portions, one of which is again subdivided. Such an appearance is suggestive of the origin of the bacillus from one of the varieties included under Group III., by a process of subdivision of one of the component portions of the diplo-bacillus.

Whilst in Group II. will be recognized some types familiar to all as diphtheria bacilli—e. g., type A^1, B^1 and C^1—many of the

more regular forms—as D^1 and E^1—are not to be distinguished from those described by certain authorities as xerosis bacilli. It will be noted that this group of type forms is not so complete as Groups I. and III. This is because in this laboratory barred forms co-ordinate in size and shape with F and E have not been observed. Should they at any time be found, the types F^1 and E^1 will be added to the group.

Group III. *Solid Color Forms.*—These include not only the solidly staining forms of all shapes and sizes, but also those with the appearance of diplo-bacilli. The former, perhaps more especially the larger forms, would be acceptable to the majority of observers as diphtheria bacilli. The latter were formerly included for the most part by us under our "atypical" forms, and have been looked upon as pseudo-diphtheria bacilli by Hoffmann and others. It seemed better to place them in this group than with the barred varieties, because the paired arrangement is so frequent that we were at first inclined to believe it to be constant in some strains. The intensity of coloration varies in different bacilli in the same variety, and there may be some shading in the same individual.

TYPES IN DETAIL.

Types A, A^1 and A^2. (See Plate I., Figs. 1, 2 and 3.) These are ordinarily described as involution forms. Here are included those swollen "bizarre" bacilli which appear as spherical, semilunar, "dumb-bell," "Indian-club" and "ghost" forms. Portions of certain of these may be as much as 3 microns in diameter, though usually 1 to 2 microns thick by 3 to 6 microns long. Many, if not all of these, may be found in:

(a) Direct smear preparations from clinical cases.

(b) Either young or old cultures made directly from clinical cases as well as from healthy individuals.

(c) Either young or old cultures which have been kept in the laboratory for many months, derived originally from clinical cases or from healthy people.

In view of these facts their inclusion amongst "degeneration or involution" forms is questionable.

The distinction between A and A^1 is rendered somewhat difficult at times by the occurrence of barred varieties containing one or more metachromatic polar granules. In all three types there is the greatest variability in the staining reaction, causing some difficulty in diagnosis. No one of the types represented can be

considered an impossible form of bacillus diphtheriæ when occurring with the others. Certain of them—in type A^2—if found as the only microbe present, besides staphylococcus or streptococcus, in a throat culture would not suggest a diagnosis of diphtheria.

In these types the adoption of a single form as the type of the group which governs the classification elsewhere has been purposely avoided. Their one common characteristic is their swollen appearance. The virulence of these three types to man is probable from their frequent great abundance and almost constant presence in small numbers in all cultures derived from clinical cases. They are, however, rarely or never the predominating types in pure cultures which have been shown to be virulent to animals.

Types B, B^1 and B^2. (See Plate II., Figs. 1, 2 and 3.) Types lettered B, B^1 and B^2 are also by some observers spoken of as "involution" forms and by many others as "attenuated" forms. They are long and slender (about 0.5 micron in thickness and 3 to 7 microns in length), while the granules in B and the segments in B^1 usually have the longitudinal diameter considerably greater than the transverse. The granules in B rarely, if ever, show metachromatism, and do not swell the body of the bacillus. This type (B) has been found as almost the sole diphtheria-like organism present in a series of cultures from a case of typical clinical diphtheria and proven to be highly virulent to guinea pigs.

Types B^1 and B^2 have not been found as the predominating forms in direct throat or nose cultures, though sometimes present in small numbers. It will readily be seen from the resemblance in size and shape of type B^2 to various common bacteria of the mouth that it would be very unsafe to diagnose this type as bacillus diphtheriæ except when it occurs as a variant in pure cultures.

Type C. 0.5 to 1 micron thick by 3 to 6 microns long. (See Plate III., Fig. 1.) (The usual length of 4 microns may be increased to 6 microns in those forms which seem to be about to divide.) Often somewhat curved forms, in which protoplasm stains light blue except always at poles and occasionally at one point beween the poles, where rounded, rarely ellipsoid granules occur. These granules show metachromatism, i. e., stain dark blue with a marked reddish tinge, and are thicker than the rest of the bacillus.

This form is the most common one met with in clinical cases, and may be considered the "long" form of bacillus diphtheriæ, as contrasted with the "short" form of most observers.

Type D. 0.75 to 1 micron thick by 2 to 3 microns long. (See Plate IV., Fig. 1.) Similar in most respects to C, but shorter and thicker and apparently straighter.

Type E. 0.5 to 0.75 micron thick by about 1.5 microns long. (See Plate V., Fig. 1.) Otherwise like D. D and E comprise probably the "short" forms of bacillus diphtheriæ of other observers.

Though types C, D and E are ordinarily diagnosed without hesitation as baccillus diphtheriæ, yet when considering them in relation to the other types herewith described, it must not be forgotten that they are frequently met with in the throats or noses of perfectly healthy persons not recently exposed to clinical diphtheria. Further, they sometimes fail to show any degree of toxicity when tested on guinea pigs.

Type F. 0.25 to 0.5 micron thick by 1 to 2 microns long. (See Plate VI., Fig. 1.) Small, slender bacilli with tapering extremities. The bacilli stain light blue and contain one or two rounded granules of an intense dark blue with a reddish tinge, i. e., metachromatic. The granules occur at one end or near the middle, or in both places. The granules are thicker than the rest of the protoplasm which tapers from their point of occurrence toward the ends. This form is extremely rare, and its pathogenesis has not yet been studied.

Type G. 0.5 to 0.75 micron thick by 1 to 1.5 microns long. (See Plate VI., Fig. 3.) Shortest granular form. Bacilli usually paired. Each pair resembles a dark-blue ellipsoid divided transversely by a clear, narrow space. Granules are very small, difficult to see, and occur only at the distal extremities of the pairs. They stain an intense blue, and occasionally show a slight trace of red. Has been very rarely found in clinical cases, though its pathogenesis for guinea pigs has been shown in cultures from a non-clinical case.

Type C^1. 0.5 to 1 micron thick by 3 to 6 microns long. (See Plate III., Fig. 2.) Long curved forms usually thicker at one end, or straight forms thicker in the middle, with bluntly pointed ends. Its characteristic is a dark-blue color with four to eight lightly stained or white transverse bands.

In the experience of this laboratory this form, so commonly figured in text-books as the type, is not so frequently found as the larger forms with polar granules.

Type D^1. 0.5 to 1 micron thick by 2 to 3 microns long. (See

Plate IV., Fig. 2.) As compared with C^1 this form is shorter, has fewer bands and is usually straighter.

Type E^1. 0.5 to 0.75 micron thick by 1.5 to 2 microns long. (See Plate V., Fig. 2.) Otherwise like D^1 except that staining is more frequently lighter.

Types C^1, D^1 and E^1 have been described by numerous observers as xerosis bacilli, although the occasional etiological relation of C^1 to clinical diphtheria is fairly well established.

Type C^2. 0.5 to 1 micron thick by 3 to 4 microns long. (See Plate III., Fig. 3.) Curved or straight forms, usually slightly clubbed or tapering at both ends. Stains a fairly uniform intense blue, no metachromatism; granules and barring absent. Infrequently met with, but up to the present time never found by us as the predominating form, even in pure cultures which have been long under study. Its virulence to man and animals is, therefore, a matter of conjecture alone.

Type D^2. 0.75 to 1 micron thick by 1 to 2.5 microns long. (See Plate IV., Fig. 3.) Bacilli generally present the appearance of pairs with opposing extremities flattened and thickened. Whether the light or colorless portion seen between is unstained protoplasm in a long bacillus or an actual space between two opposed bacilli cannot yet be stated. It is probable that one condition is succeeded by the other, since solid bacilli of the same shape, length and thickness are always present in pure cultures which have been repeatedly sown from isolated colonies, and are included in this type. The distal extremities of the paired forms are bluntly pointed or abruptly rounded. All bacilli stain a fairly intense even blue. Metachromatism is absent.

This is the type to which particular attention was drawn in a former communication as the "atypical" form of B. diphtheriæ.[1] It is the most prevalent form at Owatonna, is occasionally the only form present in clinical cases, and is frequently pathogenic to guinea pigs. When so, protection is afforded by the use of commercial diphtheria antitoxin.

Type E^2. 0.5 to 0.75 micron thick by 1 to 2 microns long. (See Plate V., Fig. 3.) Very like D^2 except that it is smaller and apparently straighter.

D^2 and E^2 are probably included under the "pseudo-diphtheria" or "Hoffmann" group of bacilli of other observers. They are frequently found together. Frequently each occurs in pure cultures

[1] British Medical Journal, April 16, 1898.

without admixture with other forms. This is true also of direct throat or nose cultures. The pathogenesis of E^2 yet remains to be determined.

Type F^2. About 0.25 micron thick and 1 to 2 microns long. (See Plate VI., Fig. 2.) Small, slender bacillus, with one or both extremities tapering. Stains an even, usually light blue. Frequently arranged in pairs like D^2 and E^2. A rare form, and one which, like B^2, would not be recognized as related to diphtheria in throat cultures, but only so when found as a variant in pure cultures.

Type G^2. 0.5 to 0.75 micron thick by 1 to 1.25 microns long. (See Plate VI., Fig. 4.) A bacillus resembling D^2 and E^2 in staining and arrangement, but shorter. Has almost diplococcus appearance and resembles E, except for the presence of granules.

VARIATIONS IN TYPE.

The study of variations in types is complicated by the fact that there is usually admixture of types in both original and pure cultures. Attempts have been made to determine the sequence of forms:

(a) In cultures derived from clinical cases for routine diagnosis for establishment and maintenance of quarantine.
(b) In cultures from throats and noses of healthy children under complete individual isolation.
(c) In pure cultures isolated as previously described.

(a) After the first positive report is given in a clinical case the patient is supposedly placed in complete individual isolation. The maintenance of strict isolation in private families is, of course, difficult, and usually abundant opportunities are given for the transfer of bacteria from attendants and surroundings to the patient. Consequently such transfer cannot be absolutely excluded as the possible cause of the appearance of new types of bacilli in the patient during the course of the disease. The disturbing factor, however, is probably very seldom actually operative, as will appear from a study of the following clinical cases:

Case No. 1 (E. S., No. 8166).

Exam. No.	Types present.	Exam. No.	Types present.
1	C, D. E.	5	C, E, A, D.
2	A, D, C.	6	D, E, A, E^2, D^1.
3	A, C, D.	7	B^1, D^1, E, D, A, D^2.
4	C, A, D.	8	D^2, D^1.

Case No. 2 (W. D., No. 8181).

Exam. No.	Types present.	Exam. No.	Types present.
1	C, A, D.	3	E^2, C, D, A, D^2.
2	C, D, A, E.	4	D^2, E^2, D^1, C^1, D, A^1, G^2.

Cases Nos. 1 and 2, in which the cultures were taken during a period of about three weeks, show (a) the presence of large granular types, with absence of other types during the prevalence of clinical symptoms, and (b) the entire replacement of granular types by barred and solid types as convalescence was established and just prior to the entire disappearance of all diphtheria-like organisms. This seems to be the usual order of variation in clinical cases, as has been noted by other observers and frequently in this laboratory.

That exactly the opposite conditions may obtain is shown by the following:

Clinical Case No. 3 (R. S., No. 7693).

Exam. No.	Types present.	Exam. No.	Types present.
1	D^2, E^2.	4	D, D^2, E^2.
2	D^2, E^2, D^1, E^1.	5	D, C, A.
3	D^2.	6	D, C, E, A.

Here it will be seen that with the onset of symptoms only solid types of bacillus diphtheriæ were present, and that not until the fourth culture—third week of the disease—did the granular types appear. They then became and remained the only types found until the final entire disappearance of all diphtheria-like organisms. Such cases, in the experience of this laboratory, are infrequent, but that they do occasionally occur is beyond question.

(b) Variations in the types found in a series of original throat or nose cultures from children, even under complete individual isolation, may be more apparent than real. In complete individual isolation there is no opportunity for the introduction of other forms from other persons. It must be remembered, however, that there is no possibility of determining definitely the flora of the entire body of the patient himself. An examination of the throat is not an exact index of the various types to be found in the nose. When both nose and throat show the forms in synchronous cultures, the Eustachian tube, the eye, skin or other portions of the body may prove to be the source of subsequent invasion by other types. Notwithstanding these difficulties, since knowledge of the morphological variation of bacillus diphtheriæ within the human body seems so important, every opportunity for such study should be embraced. This requires the observance of the most careful technique. Portions of the patient's body not being examined must be kept as clean as possible by frequent bathing and by the use of antiseptic solutions. The cultures must be taken over all accessible portions of the throat, nose, eye, etc. Care must be taken

to avoid any fluctuation in the medium, in the temperature and period of incubation and in the details of staining. The cover-slip preparation must contain material from all portions of the culture, and must be patiently and carefully searched. The "personal equation" should be eliminated as far as possible by having all the observations of a series made by the same microscopist.

Examinations of 189 cases, made so far as possible under the above conditions, have failed to show such great variation due to accidental causes as might have been expected on theoretical grounds. A few cases will serve to illustrate results obtained. The types are indicated in order of their predominance in the slide examined.

Case No. 4 (H. C., No. 3683, McD.).

Exam. No.	Types present.	Exam. No.	Types present.
1	E^2, G^2, F^2.	5	E^2, D, E, E^1, D^1, C^1.
2	E^2, D^2.	6	E^2, F^2.
3	E^2, D^2.	7	E^2, D^2, D.
4	E^2, D^2, D, C.	8	E^2, G^2, E^1, D^1, D^2.

It will be seen here that E^2 was the predominating form throughout. D^2 was present in all cultures except the first and sixth. Variation to other solid forms occurred three times, to barred forms twice, and to granular forms but once.

Case No. 5 (C. A., No. 2918, McD.).

Exam. No.	Types present.	Exam. No.	Types present.
1	E^2, G^2, D^2, B^2.	3	E^2, G^2, E, G.
2	E^2, D^2.	4	E^2.

Here, again, E^2 was the predominating type in all cultures. It was associated with closely related solid forms three times, and granular forms occurred but once.

Case No. 6 (M. J., No. 50, McD.).

Exam. No.	Types present.	Exam. No.	Types present.
1	D^2, E^2, G^2, D^1, E^1.	4	E^2, G^2, D^2.
2	E^2, D^2.	5	E^2, G^2, D^2, F^2, F.
3	D^2, E^2, E^1.	6	D^2, E^2, C^2.

Here D^2 and E^2 were present throughout and alternated in predominance. Other closely related solid and barred forms were present five times, and a granular variety but once.

Case No. 7 (E. A., No. 1078, McD.).

Exam. No.	Types present.	Exam. No.	Types present.
1	E^2, D^2, E^1, D^1.	5	D^2, C^2.
2	E^2, D^2, A^2.	6	E^2, D^2, C^2.
3	D^2, E^2, D^1, B^1, A^2, C^2, B^2.	7	D^2, E^2.
4	D^2, E^2, A^2.		

In this case D^2 was prominent throughout, while the variation was only to other solid forms and twice to closely related barred forms.

CASE No. 8 (A. C., No. 3975, McD.).

Exam. No.	Types present.	Exam. No.	Types present.
1	E^2, D^2, E^1, D^1, C^1.	4	E^2, F^2, E^1, D^1.
2	E^1, D^1, E^2, D^2, C.	5	G^2, E^2, E^1.
3	B^1, D^1, E^1, F^2.		

This case presents a marked predominance of barred types with some variation in each culture to closely related solid types.

CASE No. 9 (L. C., No. 1136, McD.).

Exam. No.	Types present.	Exam. No.	Types present.
1	C, D, E, A, B^1.	5	E, F, C, B^1, C^2, C^1, E^2, F^2.
2	B^2, C^2, C^1, C.	6	D, C, E^2, F, B.
3	E, C, B^1, B^2.	7	D^2, C, D, E, F^2, F, G^2.
4	C, D, E, F, E^2.	8	E^2, E, D, C, G.

In this case granular types are in marked predominance with C and D as the leading types. Variation, however, is very great, ranging in the granular group from the largest to the smallest (A to G), and to barred or solid types in every culture.

This serves to illustrate the fact, frequently observed, that the variability of the granular types of bacilli is greater than that of the solid forms.

(c) Twenty pure cultures isolated from various sources by streaking out from selected single colonies as each subculture was made have been selected as illustrating the variation in type in serial examinations of pure stocks. The results have been tabulated and are presented in the accompanying table of "Morphology."

This table is too voluminous for anything more than a few generalizations, and a better understanding of the matter will be arrived at by the selection and careful study in detail of a few of the stocks.

PURE STOCK, No. 1. (Clinical Case, No. 3834).

	16 to 18 hours.	40 to 45 hours.	90 hours.
1. Original throat culture	C, D, E, E^2.		
2. Pure culture* . . .	B, C, A.	C, D, A.	B, C, A.
3. " " . . .	B, D, D^2.		C, D, E.
4. " " . . .	C^1, D^1.		
5. " " . . .	D, E, G, C.		
6. " " . . .	D^2, E, C^1.		
7. " " . . .	D^2, C^1.		
8. " " . . .	A, C, B.	C, C^1, A.	

*Two years after isolation.

It is interesting to note that in this stock, type C, originally the predominating form, was still present two years later, though with it were the so-called "attenuated and swollen involution forms" B and A. To regard them in this case as involution forms is unwarranted, when it is seen that the stock reverts to the shorter granular, barred and solid types, though A and B are again present in the last examination of the young serum cultures. It will be noticed that on one occasion the barred or "xerosis" forms, C^1 and D^1, were present without admixture with other types, though no barred forms were present in the original culture. This is of interest, because this stock originated from a virulent clinical case in which the bacilli persisted for a long time in the throat. It has proven virulent for guinea pigs in every one of many inoculations.

Type C, or one of its nearest neighbors amongst the long types in the accompanying sketches, was present in every examination. The presence of C did not seem to be influenced by the age of the culture at the time of examination.

Pure Stock No. 2. (Clinical Case, No. 3837).

	16 to 18 hours.	40 to 45 hours.	90 hours.
1. Original throat culture	C, D.		
2. Pure culture† . . .	B, C^1, C, D^2.	B, C, C^1, A.	B, C, C^1, A.
3. " " . . .	D, E, B, D^2.		C, D, E, A, C^1.
4. " " . . .	B, C^1.		
5. " " . . .	A, D, E.		
6. " " . . .	B, A, C, C^1.		
7. " " . . .	B, C, A, C^1.		
8. " " . . .	A, C, B.	C, C^1, A.	

In this stock only one solidly staining type (D^2) was found present, and that only on two successive occasions, and then was less numerous than the other forms. The general tendency is to the predominance of the long forms throughout. The culture has remained virulent for guinea pigs throughout its whole history, and was obtained from a severe clinical case.

Pure Stock, No. 3. (Clinical Case, No. 6175).

	16 to 18 hours.	40 to 45 hours.	90 hours.
1. Original throat cultures	D, E^2.		
2. Pure culture* . . .	D^2, C^2.	G^2.	D^1, D^2, D, A^2.
3. " "	D^2, E, C^2.		
4. " "	D^2, E^2.		
5. " "	D^2, G^2, G.		
6. " "	D^2, E, E^2.		
7. " "	D^2, C^2.		
8. " "	F, E^2.	D^2, G^2.	

†Two years after isolation.
*About one year after isolation.

In this stock the persistent predominance of the solid types (D^2 and E^2) is very marked, though almost every culture shows short granular types (usually considered non-virulent) present. This is of special interest, since the stock is from a clinical case and proved to be pathogenic to guinea pigs whenever tested.

PURE STOCK, No. 4. (Non-clinical Case, No. 4303, McD.).

		16 to 18 hours.	40 to 45 hours.	90 hours.
1.	Original throat culture	C, D.		
2.	Pure culture† . . .	D, F, D^2, C.	D, B, A.	B, A, C^1.
3.	" "	C, D, E.		C, D, E, A.
4.	" "	B, A.		
5.	" "	A. B.		
6.	" "	C, D, A.		
7.	" "	B, C.		
8.	" "	A, D, D^2, E^2.	D, E, C^1, A.	

Though this stock was obtained from the throat of a child, who at no time gave any evidence of clinical diphtheria, had not been exposed to clinical diphtheria, and at the time of taking the culture was in complete individual isolation, yet the original and almost every subculture of it showed only granular types, i. e., those usually considered as diagnostic of diphtheria. The stock is virulent to guinea pigs. This stock is of peculiar interest, since, except for the entire absence of clinical symptoms in the patient, it would have been impossible at all times to have differentiated it for diagnostic purposes from Stock No. 2 (from a marked clinical case).

PURE STOCK, No. 5. (Non-clinical Case, No. 5218, McD.).

		16 to 18 hours.	40 to 45 hours.	90 hours.
1.	Original throat culture	C, D, E^2.		
2.	Pure culture* . . .	B, C, C^1.	C, D, E, A.	B, C, A.
3.	" "	C, D, E, E^2.		C, D, E, A.
4.	" "	A, B, C, D, E, E^2.		
5.	" "	A. C.		
6.	" "	A, C, D.		
7.	" "	C^1, B, A.		
8.	" "	C, D, C^1, A.	D, C^1, E, A.	

This stock also was obtained from a child without clinical symptoms of diphtheria, not recently exposed to diphtheria, and under strict individual isolation when the culture was taken. The large granular types are present and predominating, but it has not been possible to kill guinea pigs with this stock with large doses of grown cultures.

†Nine months after isolation.
*Eight months after isolation.

The similarity of the predominating granular types in Stocks Nos. 2, 4 and 5 is remarkable when considered in connection with their great dissimilarity in virulence. Thus, No. 2 is from a clinical case and is highly virulent to guinea pigs; No. 4 caused no symptoms in the child-host, but is virulent to guinea pigs; No. 5 caused no clinical symptoms and is not at all virulent to guinea pigs. We seem to have here three distinct grades of virulence without any corresponding change in morphological type.

Pure Stock, No. 6. (Non-clinical Case, No. W.)

		16 to 18 hours.	40 to 45 hours.	90 hours.
1.	Original throat culture	D^2.		
2.	Pure culture† . . .	D^2.	D^2, E^2, G^2.	D^2, G^2, E^2.
3.	" "	E^2, D^2.		G^2, E^2.
4.	" "	G^2.		
5.	" "	E^2, G^2.		
6.	" "	E^2, D^2.		
7.	" "	E^2, G^2.		
8.	" "	D^2.	D^2, E^2.	

This stock was obtained from the throat of one of the writers soon after a short visit to the State Public School, where bacteria of the types found were present in many noses and throats. A slightly reddened, swollen sore throat was the reason for taking the original culture. These symptoms quickly subsided, and the bacteria disappeared, under treatment with antiseptic gargles, from the throat within a few days. It will be noted that at no time in the history of the stock were other than solid types (D^2, E^2, G^2) present, yet the cultures readily killed unprotected guinea pigs, while others of the same size and weight remained alive and well after synchronous injection with large quantities of the bacteria mixed with commercial antitoxin. It would thus appear that the stock is true diphtheria, though it caused but slight symptoms in man and is of the morphological type described by many observers as "pseudo-diphtheria."

When the observations here recorded were begun the stocks had been isolated by a repetition of this process of colony picking and subsequent "streaking out" from three to fifteen times. Each subculture having been made in the same way, it is apparent from the tables* that the stocks at the time of the last observation had been subjected to this purification process from twenty to forty or more times.

†One year after isolation.

*The tables presented at the meeting were much more voluminous than those here given. Tables were also exhibited there which are not given here at all.

Assuming that where the initial throat cultures were mixtures of different groups of types, it might be expected that in most of such stocks a single type, or its neighbors within the same group, would have been the result of the long-continued selective process, and this has been found to be true. Examinations of the later cultures of most of the stocks show that, as a rule, some, and generally all of the types met with in the original throat cultures are found again late in the series of examinations. If not grouped in one specimen, as they were in the original throat or nose culture, all of the original types are usually found present scattered throughout the later cultures. To illustrate, when we have granular and solid types in the original culture we rarely find, so far as can yet be determined, permanent disappearance of one of these initial types in the later examinations.

It appears that the granular types, when predominating or unmixed with the barred or solid types in the original cultures, have, however, a tendency, as in throat cultures taken in series, to become more and more mixed with or replaced by barred or solid forms altogether in the later examinations. Insufficient data is available to warrant any such positive statement at the present time.

Certain of these stocks, however, in which one of the solid types is the only diphtheria-like organism seen in the original throat culture, and in which the immediately succeeding subcultures show only solid types, are found to contain later in the series some of the barred or granular types and seem to show a gradual transition from solid types through barred to granular types.

Whether a parallelism really exists or not between variations in type as they occur in series of pure cultures or in throats from day to day cannot be definitely stated, though such would appear to be the case.

In general it may be stated that in successive cultures of any stock in which the isolation method employed would lead one to expect the loss of certain forms originally present, all are, on the contrary, usually preserved. Notwithstanding the fact that with the types originally present there may occur later other types in the same or different groups, there is a strong tendency to preserve some one or two types throughout the series.

RECORDING OBSERVATIONS IN ROUTINE EXAMINATION FOR DIAGNOSIS.

It is hoped that the adoption of the uniform system of recording observations in routine examinations may ultimately result in the

solution of several etiological problems. There is given below the results of the examination of the original throat cultures from the last hundred cases of clinical diphtheria on which positive bacteriological diagnoses were made in this laboratory.

	Cases.
Granular types alone present	42
Barred types alone present	0
Solid types alone present	8
Mixture of granular and barred types present, solid types absent	8
Mixture of granular and solid types present, barred forms absent	30
Mixture of barred and solid types present, granular types absent	1
Mixture of all three types	11
Total	100

The granular types will be seen to be most numerous, and 91 per cent of the cases showed their presence, while they were present without admixture of other types in but 42 per cent.

The barred types were never found alone, but in mixtures of types were present in 21 per cent of the cases. The solid types were present as the sole discoverable form of diphtheria bacillus in but 8 per cent of the cases, and in mixtures of types in 50 per cent.

So far as these examinations can be relied upon for proof of the etiological relation existing between the various types and clinical diphtheria, it would seem that the granular forms are much more frequently the cause of clinical diphtheria, C and D being by far the most common forms found. C and D were found occurring together in 61 per cent of the cases. D was found in 78 and C in 63 out of the 91 cases in which the granular forms occurred, so that when C was present it was mixed with D in 61 out of 63 cases.

RELATION OF CULTURAL TO MORPHOLOGICAL PECULIARITIES.

An extended series of observations on the cultural characteristics of various pure stocks has been made. Parallel sowings were made on all the ordinary culture media and on various modified forms of bood-serum. The full discussion of these observations would much exceed the limits of the present paper.* It may be sufficient to note here that the variations in cultural characteristics are almost as great as those in morphology, though in general they are embraced within the limits of the results hitherto obtained by other observers. The extreme difficulty of maintaining

*Tables illustrating these points were exhibited at the meeting.

a given type free from admixture with other types has necessitated most of the observations being made on groups of closely related types rather than on a single one. Where this has been the case stocks containing the same predominating types gave similar cultural appearances, the slight variations being, perhaps, due to the dissimilarity of the subordinate morphological types in the stocks.

A full discussion of this series of observations must be reserved for a future communication.

PATHOGENESIS TO MAN AND ANIMALS, AND QUARANTINE REGULATIONS IN RELATION TO MORPHOLOGICAL TYPES.

Further than the brief mention given to these points in the preceding portion of the paper, little need be said.* Variation and mixture of types are constantly found, and unless the associated types be closely related we cannot assume at this stage of our knowledge that every one of the types represented would be virulent if found alone, even when the culture is obtained from a severe clinical case or proves fatal to guinea pigs. This must be the case unless we are prepared to admit that any one of the types here classified is capable of change into or replacement by any one of the other types.

If it be admitted, for instance, that any of the already well recognized types may change into A, as would appear to be the case from its general acceptance as an involution form, where must the line of possible variation be drawn? G and G^2 would appear to be beyond all possibility of inclusion as diphtheria bacilli, but in one experiment, when these types were present in one of our carefully isolated pure cultures, without other detectable admixture, on inoculation into a guinea pig, death was produced in less than forty-eight hours, and the culture isolated from the site of inoculation showed forms D^1 and a few D^2 as the only diphtheria-like organisms.

In quarantine measures, if the bacteriological method be employed, it must combine speed with accuracy.

Morphology and staining must continue to be, perhaps, the most important basis of diagnosis. But these recognize only one variable factor, viz., the bacilli, and ignore the local and general resistance of the host.

*Tables illustrating these points were exhibited at the meeting.

In general, then, we are driven to dependence upon the association of clinical symptoms and any of these forms when it is the predominating form of microbe in the throat.

SUMMARY.

1. The routine bacteriological diagnosis of diphtheria for establishment and maintenance of quarantine must continue to depend largely on the observation of bacilli in twelve to twenty-four-hour serum cultures from the throats of patients.

2. The great variety of forms met with in such cultures—some of them virulent and others not—is bewildering, even to the best trained diagnosticians.

3. Our present methods of describing the forms met with are inaccurate, incomplete and unintelligible to others.

4. To overcome this difficulty there is submitted a detailed description and arbitrary classification of types of known and probable diphtheria bacilli, as observed under all conditions on Löffler's blood-serum and stained with Löffler's methylene-blue.*

5. This classification places all types in three general groups: (a) Granular, (b) barred, and (c) solid (or evenly staining) forms. Each group is divided into types based on the shape and size of the bacilli.

6. A study of variations in the sequence of types in series of cultures derived from clinical cases of diphtheria shows that:

(a) Granular types are usually the most predominant forms at the outset of the disease.

(b) The granular types usually give place wholly or in part to barred and solid types shortly before the disappearance of diphtheria-like organisms.

(c) Solid types, by many observers called "pseudo-diphtheria bacilli," may cause severe clinical diphtheria.

(d) Solid types may sometimes be replaced by granular types when convalescence is established and just before the throat is cleared of diphtheria-like bacilli.

7. A study of variations in the sequence of types in a series of cultures in the throats and noses of healthy but infected children under complete individual isolation shows that:

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*Roux's, Ernst's, Crouch's and Neisser's methods, and a number of modifications of them, have all been tested in this laboratory, and all of them abandoned in favor of Löffler's method for routine diagnostic work, since, while all of them possess certain special advantages, none of them gives as much data concerning mixed cultures as does Löffler's stain when properly used.

TABLE OF MORPHOLOGY.

Laboratory No.	Clinical Cases.			Non-clinical Cases (Faribault).				
	3834	3837	6175	6476	6489	6526	6578	6606
Variety of B diphtheriæ at original examination	C D E E^2	C D	D^2 E^2	D^2	D^2 D B A C^2	D^2 E^2	E^2 G^2	D^2
Associated bacteria at original examination	None (?)	None (?)	Staphylococci	Sarcinæ staphylococci slender bacilli	None (?)	Staphylococci large bacilli	Streptococci staphylococci small bacilli	Staphylococci streptococci
Pure cultures grown subsequently on Löffler's blood serum mixture plus 1¼ per ct. glycerin, coagulated and sterilized in the autoclave. All cultures in the same line made on the same lot of medium. — 16 hours	B C A	B B^1 C D^2	D^2 C^2	D^2 G^2	G^2 D^2	D^2 G^2	G^2 D^2	D^2 G^2
45 hours	C D A	B C B^1 A	G^2	D^1 D	E G G^2 D	E^2 D^2	D^2 E^2	G G^2
90 hours	B C A	B C B^1 A	D^1 D^2 D A	C D B^1 D^1 A	G^2 D^2 D	G D^2 E	G G^2 E^2	D^2 G^2
16 hours	B C D	C D E F G^2	D^2 B^2	E^2	E^2 D^2 G^2	D^2 E^2	D^2 E^2 G^2	E^2 G^2
60 hours	C D E	C D E A B^1	D^2 E B^2	B^1 D^1	D E A	G^2 G	G^2 G E^2	G^2 E^2
Sown from broth culture 1 day old 18 hours	B^1 D^1	B B^1	D^2 E^2	D^2	D^2	D^1 B^1	E^2 D^2	D^2 E^2
Sown from broth just inoculated 18 hours	D E G C	A D E	D^2 G^2 A	B^1 D^1	D E	G E D	E^2 G^2	E G D^2
Broth culture 20 hours	D^2 E B^1	Contaminated	D^2 E E^2	D^2 E^2	D E D^2 C	D^1 D^2 E	D^1 B^1 D^2	D^1 B^1 D^2
16 hours	D^2 B^1	B A C B^1	D^2 B^2	E^2 G^2	E^2 F^2	G^2 E^2	E^2 D^2	E^2 D^2
18 hours	A C B	A B C	F E^2	No visible growth	D^2 B^1 E	No growth	No visible growth	G^2
40 hours	A C D B	C D E A B	D^2 G^2	G^2	D E B^2 G^2	No growth	G^2	G^2 D^2

Laboratory No.	Non-Clinical Cases (Owatonna).					
	7097	4303 McD.	2548 McD.	5218 McD.	5199 McD.	4301 McD.
Variety of B diphtheriæ at original examination	G^2 G E^2 F E D A	C D	D^2 D E^2	C D E^2	C D A	G E^2 E
Associated bacteria at original examination	............?	Staphylococci	Staphylococci	None (?)	None (?)	Staphylococci
Pure cultures … — 16 hours	G G^2	D F D^2 B^1	B^1 D^1 D G^2	B C B^1	B C B^1	D^2
45 hours	G G^2 E^2	D B A	D B B^1	C D E A	C B B^1	E^2 D^2 G^2
90 hours	D^2 G	B A B^1	C D E	B C A	B C A	E^2 D^2 D^1 A
16 hours	G	C D E	D^2 G^2 B^1	C D E E^2	C D B^1	E^2
60 hours	G	C D E A	D E G^2 G	C D E A	C D E,	E^2 D^2
Sown from broth culture 1 day old 18 hours	E^2	B A	E D D^2	A B C D E E^2	C D E A G G^2	E^2 G^2
Sown from broth just inoculated 18 hours	G^2 G F	A B	G E D	A C	A C E B G^2	E D E^2
Broth culture 20 hours	No growth	C D A	D^1 E^2	A C D	C D A	D^2 E^2
16 hours	E^2 G^2	B C	B^1 D^1 D^2	B^2 B A	B D A D^2	D^2 E^2
18 hours	No growth	C D^2 F^2 A	D E D^1 B^1	No visible growth	D^1 B^1 D^2 C A	No growth
40 hours	No growth	D E B^1 A	D E	D E G^2 A	D B^1 D^2	No growth

Laboratory No.	Non-Clinical Cases (Owatonna), continued					
	4394	2352	4296 McD.	2629 McD.	7087	W.
Variety of B diphtheriæ at original examination	D^2	C D E^2	D^2 E^2	G^2 E^2	E^2 F E D^1	D^2
Associated bacteria at original examination	None (?)	None (?)	Staphylococci	Staphylococci	Staphylococci	None (?)
Pure cultures … — 16 hours	D^2 G^2	E^2 G^2	D^2 E^2 G^2	D^1 B^1 D^2 A	D^2 G^2	D^2
45 hours	E D D^1	D B^1 D^1	D B^1 B G^2	D^2 D	D^2 G^2	D^2 E^2 G^2
90 hours	D^2 G^2	C D B^1 D^1	E^2 D^2 G^2	E E^2 D^2 G^2	E D^2 G^2	D^2 G^2 E^2
16 hours	E^2 G^2 D E	F^2	E^2 D^2	E^2 G^2	D^2 G^2	E^2 D^2
60 hours	C D E	C D E A	D^2 E D^1	E^2 D^2	E^2 G^2	G^2 E^2
Sown from broth culture 1 day old 18 hours	E^2 G^2	E E^2 B^1	D^2 G^2	E^2	G^2 E^2	G^2
Sown from broth just inoculated 18 hours	E D B^1	D^2 B^1	D^2 E^2	E^2 G^2	E^2 G	E^2 G^2
Broth culture 20 hours	E^2 B^1 D^1	D^2 D^1 B^1	E^2	E^2	Contaminated	E^2 D^2
16 hours	E^2 G^2 D^1	E^2 G^2	D^2 B^2	D^2 B^2	D^2 B^2	E^2 G^2
18 hours	G^2 G D^1	D F A	No visible growth	D^2 G^2	No visible growth	No growth
40 hours	D E G D^1	D^2 E	D^2 B^1	G^2 D^2 B^2	G^2 D^2	No growth

(a) The variability of granular types under such conditions is greater than that of the solid or barred types.

(b) Any type in marked predominance at the beginning is likely to persist as the predominating type for a long period of time.

8. A study of a series of subcultures from a number of pure stocks shows that:

(a) There is a strong tendency for a type present in the original culture to persist even for a number of years.

(b) Types not found in the original culture, but closely related to types there present, may later in the history of the stock appear, disappear and again reappear.

(c) This variation may be not only in types of the same group, but also to types of similar size in other groups, e. g., the variation of granular to barred and solid types and the converse.

(d) This variation may be so complete as to entirely change the predominating types present in the stock.

9. In a hundred clinical cases selected at random, the first throat cultures showed granular types present alone in forty-two cases, solid types alone in eight cases. The remaining fifty cultures were mixtures.

10. Comparable cultural variations were obtained in a long series of sowings on ordinary media and special serum mixtures.

11. In the present state of our knowledge, data for the establishment and maintenance of quarantine must be obtained from the clinical symptoms as well as from the bacteriological findings.

ANALYSIS OF THE DISTRIBUTION OF TYPES OF B. DIPHTHERIÆ IN 608 CASES IN WHICH A DIAGNOSIS OF "DIPHTHERIA" WAS MADE IN THE LABORATORY FOR THE 14 MONTHS ENDING DEC. 31, 1900.**

After the completion and adoption of the type classification in October, 1899, in the regular routine work of the laboratory, diphtheria was diagnosed in 608 cases out of a total of 1,254 cases examined in the remainder of the year 1899 and the 12 months of the year ending Dec. 31, 1900. During these 14 months all examinations were recorded in terms of the type classification.*

At the close of this biennial period it seemed advisable to analyze the findings in all positive clinical cases for the whole period during which this method of record has been in use.

Before going into the details of the distribution of types or groups of types in these cases, a brief consideration of the conditions which might reasonably be expected to influence results seems necessary. Some of the more important are:

1. *Variation in culture medium.*

The culture medum employed throughout was a modified Löffler's serum, prepared always in the same way. Beef serum was collected in the abattoir and preserved in the ordinary manner by the addition of chloroform. The modification consisted in the addition of 1.25 per cent glycerine and the coagulation and sterilization of the serum as a single operation in the autoclave in which the temperature was very *gradually* raised to 120° C. This yields a hard, opaque serum. Serum prepared in this way has always been employed in the work of the laboratory, and was used in the formulation of the type classification.

In spite of the fact that physicians are always instructed to return outfits when medium is dry or contaminated, it is not always done. The difficulty has been partially obviated in the latter

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**The following studies on the occurrence of types of B. diphtheriae in clinical cases and in the special investigations at Bethany Home have been presented before the Canadian Medical Association, (Winnipeg, Aug. 28, 1901) and before the American Public Health Association, (Buffalo, Sept. 16, 1901). They will shortly be published as a paper by Wesbrook, Wilson & McDaniel.

*The findings in 100 consecutive cases of diphtheria were partially analyzed in May, 1900, see Transactions of the Association of American Physicians, Washington, 1900, page 217. See also, this Report, page 631. These cases are included in the present analysis of 608.

PLATE I.

FIG. 1. Type A. 1 to 2 μ thick, 3 to 6 μ long.
FIG. 2. Type A^1. 1 to 2 μ thick, 3 to 6 μ long.
FIG. 3. Type A^2. 1 to 2 μ thick, 3 to 6 μ long.

PLATE II.

Fig. 1.

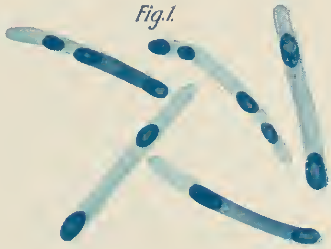

Fig. 2.

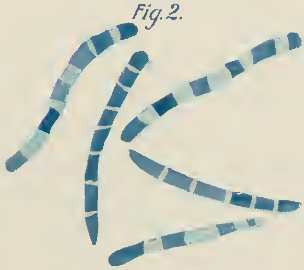

Fig. 3.

FIG. 1. Type B. 0.5 μ thick, 3 to 7 μ long.
FIG. 2. Type B[1]. 0.5 μ thick, 3 to 7 μ long.
FIG. 3. Type B[2]. 0.5 μ thick, 3 to 7 μ long.

PLATE III.

Fig. 1.

Fig. 2.

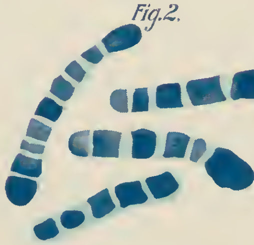

Fig. 3.

Fig. 1. Type C. 0.5 to 1 μ thick, 3 to 6 μ long.
Fig. 2. Type C[1]. 0.5 to 1 μ thick, 3 to 6 μ long.
Fig. 3. Type C[2]. 0.5 to 1 u thick, 3 to 4 μ long.

PLATE IV.

Fig. 1.

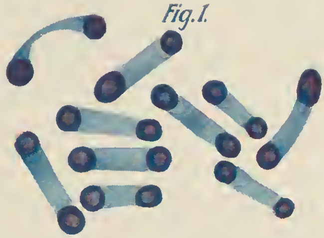

Fig. 2.

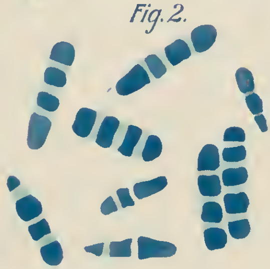

Fig. 3.

Fig. 1. Type D. 0.75 to 1 μ thick, 2 to 3 μ long.
Fig. 2. Type D^1. 0.5 to 1 μ thick, 2 to 3 μ long.
Fig. 3. Type D^2. 0.75 to 1 μ thick, 1 to 2.5 μ long.

PLATE V.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 1. Type E. 0.5 to 0.75 μ thick, 1.5 μ long.
Fig. 2. Type E^1. 0.5 to 0.75 μ thick, 1.5 to 2 μ long.
Fig. 3. Type E^2. 0.5 to 0.75 μ thick, 1 to 2 μ long.

PLATE VI.

FIG. 1. Type F. 0.25 to 0.5 μ thick, 1 to 2 μ long.
FIG. 2. Type F^2. 0.25 μ thick, 1 to 2 μ long.
FIG. 3. Type G. 0.5 to 0.75 μ thick, 1 to 1.5 μ long.
FIG. 4. Type G^2. 0.5 to 0.75 μ thick, 1 to 1.25 μ long.

months of the work by the employment of rubber test tube caps which prevents to a great extent the drying up of the medium, and throughout the whole period it has been a routine practice to resow immediately upon receipt in the laboratory all specimens sent upon swabs or dried serum. There are certain variations which it has been impossible to eliminate and whose existence must be recognized. They are:

(a) Differences in composition dependent upon the different sera obtained from time to time.

(b) Varying degrees of dryness and moisture.

(c) The occasional presence of contaminating bacteria which have been permitted to develop apparently before the use of the medium by the physician.

(d) The occasional use of swabs for the transmission of specimens.

2. *Variation of associated bacteria* and their possible effect upon the morphology of B. diphtheriæ, both in the patient and upon culture media.

3. *Delay in transit.*

This permits of the development of saprophytes. A specimen may be received in the laboratory from 6 hours to 2 or 3 days after it has been inoculated from the patient, and rarely the delay has been so great as 5 or 6 days. About 24 hours is perhaps the average time taken in transit.

4. *Time and temperature of incubation.*

Eighteen hours incubation at a temperature of 37.5° C. is the usual procedure, though some departure from it is occasionally necessary. Delays in transit, particularly in the hot weather of the summer months, considerably affect this question.

5. *Variability in stain.*

Fresh Löffler's methylene blue is always used. The stain is made up from an *old* saturated alcoholic solution of methylene blue (Grübler). The pipette bottles are usually refilled every 2 or 3 days either with freshly made stain or from a stock bottle which is tightly stoppered. Notwithstanding these precautions, there is, perhaps, some slight variation.

6. *Supposition that the specimen stained is a fair sample* of the growth is perhaps not always warranted.

7. *The technique of the physician in securing specimen* varies.

8. *The use of antiseptics in the throat* prior to the taking of the specimen. It is assumed that no antiseptic has been used, though

delayed growth in some instances has been accounted for subsequently in this way.

9. *The use of antitoxine* might be expected to have some effect upon the morphological types of bacilli present. There has been no uniformity, however, in the use of antitoxine in these cases.

10. *The nature, location and severity of the local lesion*, presence or absence of a membrane, etc., are factors which would seemingly affect results. For instance, the difficulty of securing a satisfactory specimen in a case of laryngeal diphtheria is apparent.

11. *Time of disease at which first specimens were taken.*

The major portion of this report deals with a comparison of the types of bacilli found present in the first positive examination. It may be stated that specimens were forwarded for the first time from patients at times varying from the first to the thirtieth day of the disease or later. Where the first specimen was received late in the disease, the health officer or physician desired to know the condition of the throat as a guide to release from quarantine, quarantine having been imposed in the first place on clinical grounds. In view of the variation of the conditions just enumerated, the constancy of results is all the more remarkable.

CLINICAL HISTORY.

A diagnosis of "diphtheria" was given by the laboratory in these 608 cases. In 521, or 86 per cent, a provisional diagnosis of "diphtheria" from a clinical standpoint was warranted from the symptoms. In but 24 cases, or 4 per cent, were the symptoms so insignificant as to lead to a diagnosis of "not diphtheria" on clinical grounds alone. Some of these showed no sypmtoms, but had been exposed to clinical diphtheria. Concerning the remaining 63 cases, or 10 per cent, no data was received in the laboratory, and hence nothing can be stated concerning their clinical aspects.

More minute consideration of the clinical aspects of these cases can best be made in relation to the types of diphtheria bacilli found on the initial positive examination.

There are certain types of diphtheria bacilli whose presence in throat cultures would be taken by most bacteriologists as diagnostic of diphtheria. These are types A, B, C and D (see page 635 of this Report). All cases in which any of these types were present on the first positive examination will be considered as Group I. There were 545 of these, or 90 per cent. The shorter granular types E, F and G are probably of minor pathogenic significance,

and cases in which these types were present without A, B, C or D will be considered as Group II. Of these there were 12 cases, or 2 per cent. Certain of the barred types are regarded by some observers as of varying pathogenic significance, and the cases in which these occur on the initial positive examination—all granular types being absent—will be considered as Group III. Of these there were 19 cases, or 3 per cent.

The remaining cases, those in which solid types alone were present upon initial positive examination, will be included as Group IV. Of these there were 32 cases, or 5 per cent.

Group I.

This group, consisting of those cases in which types A, B, C or D were present on the first positive examination, contains 545 cases, or 90 per cent of the whole number examined (608). The total data available in the laboratory with reference to the clinical history of these cases may be categorically expressed, as follows:

Sub-group 1..	Membrane present Physician's diagnosis "diphtheria" Antitoxine used with beneficial results	.... 94 cases
Sub-group 2..	Membrane present Physician's diagnosis "diphtheria" No data concerning use of antitoxine	... 210 cases
Sub-group 3..	Membrane present Physician's diagnosis not given Antitoxine used with beneficial results	..... 2 cases
Sub-group 4..	Membrane present Physician's diagnosis not given No data concerning the use of antitoxine	.... 42 cases
Sub-group 5..	Membrane absent (at time specimen was collected) Physician's diagnosis "diphtheria" Antitoxine used with beneficial results	.... 17 cases
Sub-group 6..	Membrane absent (at time specimen was collected) Physician's diagnosis "diphtheria" No data concerning the use of antitoxine	.... 84 cases
Sub-group 7..	No data concerning membrane Physician's diagnosis "diphtheria" No data concerning the use of antitoxine	..... 4 cases
Sub-group 8..	Membrane present Physician's diagnosis other than diphtheria, usually "tonsillitis" or "exposure to diphtheria" No data concerning the use of antitoxine	.... 18 case
Sub-group 9..	No data concerning membrane Physician's diagnosis other than diphtheria—"tonsillitis" or "exposure" Antitoxine used with beneficial results	..... 2 case
Sub-group 10..	Membrane absent (at time specimen was collected) Physician's diagnosis other than diphtheria—"tonsillitis" or "exposure" No data concerning use of antitoxine	.... 10 cases
Sub-group 11..	No data concerning membrane Physician's diagnosis other than diphtheria—"tonsillitis" or "exposure" No data concerning use of antitoxine	..... 4 cases
Sub-group 12..	Membrane absent (at time specimen was collected) Physician's diagnosis not given No data concerning use of antitoxine	.... 30 case
Sub-group 13..	No data concerning membrane No data concerning physician's diagnosis No data concerning antitoxine	.... 28 case

An examination of the data in the above sub-groups will show that the cases listed in Nos. 1 to 9, inclusive—473 cases, or 77 per cent of the total of 608—were in all probability cases of true clinical diphtheria, and would have been so diagnosed at some stage of their development, though not necessarily exhibiting unmistakable evidence of diphtheria at the time the first specimen was collected. From many of the cases the data was incomplete because the first specimen was obtained by the health officer late in the disease for release from quarantine. Thus in sub-groups 5 and 6—101 cases—in which the physician's diagnosis was "diphtheria," though no membrane was present, 10 to 30 days had already elapsed in 44 of the cases before the taking of the first specimen. Though the physician's diagnosis was "tonsillitis" or "exposure to diphtheria" in the twenty cases in sub-groups 8 and 9, the fact that a membrane was present in 18 instances (sub-group 8), and that antitoxine was used with beneficial results in the other two would indicate that they were diphtheria.

Sub-groups 10 and 11—14 cases—are similar to Nos. 8 and 9, except that there is no evidence of the presence of a membrane or of the use of antitoxine. Here, as also in sub-groups 12 and 13—58 cases—the available clinical data furnishes no evidence that the cases were diphtheria. The fact that in all of these cases the attending physicians apparently acquiesced in the bacteriological diagnosis of "diphtheria" may have some weight.

Group II.

This consists of cases in which the first positive examination showed only small granular types—E, F or G—in mixtures with barred or solid types.

Nos. 1, 2, 3 and 4 of the 12* cases were examined early in the disease. In all a membrane was present, in all the physician's diagnosis was diphtheria, and in all the administration of antitoxine caused rapid disappearance of the membrane and amelioration of the patient's condition.

Cases Nos. 5 and 6 were first examined during convalescence—10th and 23d days, respectively—from typical clinical diphtheria during which the administration of antitoxine had been early followed by marked improvement of the patient's condition.

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*It is questionable whether the 12 cases in Group 2 might not properly be included in Groups 3 and 4 since barred and solid types appeared in all the cases and the solid types were even more abundant than the granular types in 8 of the 12 cases. They have, however, been considered separately that the presence of the small granular types in the specimens might not vitiate in any way the evidence of the pathogenicity of the barred or solid types.

It is, of course, impossible to say from these examinations that types A, B, C or D were not the *initial* inefective agents in these cases, and that they had not later disappeared. The patients were, however, held in quarantine on the findings noted.

In case No. 7 the specimen—a swab—was "taken from the nostrils 4 hours after death from heart failure due to diphtheria." The findings were deemed—in connection with the clinical history—sufficient reason for taking measures to prevent the spread of possible diphtheria from the case, but there is insufficient evidence to prove that the types of bacilli found in the nose were alone responsible for the lesions in the throat where the fatal toxine was elaborated.

In case No. 8 the patient was perfectly well, but desired to be released from quarantine after being exposed for some time to typical clinical diphtheria.

In cases Nos. 9 and 10 the patients were not known to have been exposed to diphtheria, were but slightly ill, no membrane being present, and their physicians did not deem the symptoms those of diphtheria.

The specimens from two of the cases, Nos. 11 and 12, were accompanied by absolutely no data.

In the last five instances provisional positive diagnoses were given on the bacteriological findings, and other specimens were asked for.

It will thus be seen that of this group of twelve cases in which small granular types* with barred or solid types were the only diphtheria-like organisms present, only cases Nos. 1, 2, 3 and 4—⅔ per cent—present sufficient evidence for believing that the bacilli found, namely the small granular types E, F and G, were the infective agents causing true clinical diphtheria. The remaining 8 cases offer no positive clinical evidence either *pro* or *con* on this point.

Group III.

This group, consisting of 19 cases in which the initial examination showed mixtures of barred and solid types with all granular types absent, may be divided into (1) those in which barred types predominated, and (2) those in which solid types predominated. In (1) those in which barred types were the most numerous are found cases Nos. 1 to 10, which were examined early in the disease (1st to 4th day), when a membrane was present and when

*It should of course be noted that small granular types occurred also in mixtures with large granular types in about half the cases examined (297).

the physician's diagnosis was "diphtheria." Data was received concerning the use of antitoxine in but four of these, cases 1, 4, 6 and 10, in all of which it resulted in the patient's early improvement. Two others (Nos. 5 and 6) showed large granular types present in specimens examined later. There can be no doubt that these 10 cases were clinical diphtheria, and that the positive laboratory diagnosis based on the presence of barred types of diphtheria bacilli was fully warranted.

The 11th case of sub-group No. 1 was convalescent when first examined—15th day of the disease, and does not exclude the presence of types A, B, C and D early in the disease.

Sub-group No. 2 in which solid types were more abundant than barred types contains seven cases. Three of these were convalescent (No. 12, 28th day; No. 15, 12th day, and No. 16, 8th day of disease). Two cases, Nos. 17 and 18, gave a history of the presence of a membrane, but the physician's diagnosis in each instance was doubtful, since in one case (No. 17) rapid recovery followed without specific treatment, and in the other (No. 18) the membrane developed about the 10th day of scarlet fever.

In one case (No. 13) the patient was not sick but had been recently exposed to virulent diphtheria.

Concerning the remaining cases of the group, Nos. 14 and 19, no data was received in the laboratory.

Thus it will be seen that, in all seven cases of this sub-group, while the laboratory diagnosis of "diphtheria" was the only proper one from a hygienic point of view, yet no one of them offers any large amount of positive evidence that the bacteria found in the original specimen were the initial specific infective agents.

Group IV.

This group, consisting of those cases in which the first positive examination showed only solid types, contains 32 cases. From 12 of these, Nos. 1-12, specimens were examined before the 5th day of the disease, while a membrane was still present in the throat, and in which the clinical symptoms were such that the physician gave a positive diagnosis of diphtheria—except in No. 6.

Records of the use of antitoxine (were received in the laboratory) in five of these cases, in all of which its use was followed soon—except in case No. 6—by marked improvement of the patient's condition.

Case No. 6 is worthy of special mention. The specimen was from a child 7 years and 5 months old, in whose throat a membrane was present on the first day of the disease when the specimen was

taken by the physician who at the time made a diagnosis of "tonsillitis," but administered 500 units of antitoxine. The specimen was received in the laboratory, accompanied by specimens from two other cases in the same family in which the same physician had made a diagnosis of "tonsillitis." The specimens from the latter two cases showed types C and D. That from the case in question showed type D^2 as the only diphtheria-like organism present. All three were diagnosed as "Diphtheria" by the laboratory. In the meantime the case under discussion had grown steadily worse and *died on the third day of its illness.*

A careful scrutiny of all the data concerning each of these 12 cases leads unequivocally to the conclusion that each was a case of diphtheria indistinguishable clinically from the ordinary form of the disease caused by types A, B, C and D and not to be differentiated therefrom except by the variation in the morphology of the causative bacilli which in 8 of the cases were D^2, E^2 and in 4 cases D^2 alone.

In addition to these 12 cases of well-marked clinical diphtheria, in this group, Nos. 13 and 14 may perhaps be considered as mild diphtheria, since while no history of exposure to clinical diphtheria could either be established or excluded, and while no membrane was present in either case. yet each patient had a marked sore throat with *malaise* and a temperature ranging from 99 to 101° for several days, while bacteriological examinations, made daily in one case, revealed no other possible etiological factor than solid types of B. diphtheriæ—principally D^2 and E^2.

Two other cases—Nos. 15-16—which showed only D^2 and E^2 on the first and only examination, were diagnosed as "doubtful" or "tonsillitis" by the attending physician.

A membrane was present in one of these cases, and in that it was confined to the tonsil. Antitoxine was not used in either case. While it is probable, owing to the absence of other bacteria from the cultures, that the lesions were caused by D^2, E^2, yet if the clinician's judgment is to be accepted the symptoms were not such as to warrant a diagnosis of "diphtheria," but rather of "tonsillitis."*

Twelve cases—Nos. 17-28—were in the convalescent stage—10th to 32d day after the onset of symptoms—when the first examination was made, and present no conclusive evidence that types

*The question may properly be raised as to the existence of a non-membranous tonsillitis due to certain types of B. diphtheriae.

D^2 and E^2, then found, were alone present during the active stage of the disease.

Three cases—Nos. 29-31—were of persons not sick but who had been recently exposed to clinical diphtheria. Concerning the last case, No. 32 of the group, no data was received.

Occurrence of the Various Types of B. Diphtheriae.

The following table—No. 29, shows the frequency of occurrence of the various types in the first positive examination of each of 608 individuals in which diphtheria was diagnosed by the laboratory from October, 1899, to December 31, 1900:

TABLE No. 29.

Granular types.....	A	B	C	D	E	F	G
No. of times present	240 (39%)	20 (3%)	403 (66%)	509 (83%)	297 (49%)	13 (2%)	23 (4%)
Barred types........	A^1	B^1	C^1	D^1	E^1	F^1(?)	G^1 (?)
No. of times present	61 (10%)	70(11%)	170 (28%)	197 (32%)	44 (7%)	2(0.3%)	0
Solid types..........	A^2	B^2	C^2	D^2	E^2	F^2	G^2
No. of times present	18 (3%)	20 (3%)	32 (5%)	333 (55%)	237 (39%)	20 (3%)	27 (4%)

The order of frequency of occurrence, therefore, is as follows: D, C, D^2, E, A, E^2, D^1, C^1, B^1, A^1, E^1, C^2, G^2, G, B, B^2 and F^2 (equal), A^2F, F^1(?)G^1(?).

TABLE No. 30,

Showing the frequency of occurrence of the more usual combinations of types in the first positive examination of 608 cases.

Combination......	CD	CDA	CDE	CD+C^1 or D^1	CD +D^2 or E^2
Times present....	373 (61%)	188 (31%)	180 (30%)	144 (24%)	206 (34%)
Combination......	C^1D^1	DE	DEA	DE+D^2 or E^2	....
Times present....	137 (23%)	279 (46%)	112 (18%)	170 (28%)	....
Combination......	....	D^2E^2	D^2E^2A	C^1D^1A	....
Times present	....	180 (30%)	121 (20%)	98 (16%)	....

From a study of all the tabulated data at hand—only a portion of which it has been possible to incorporate in the above condensed tables—the following general statements may be made:

Type A. This type occurred in 240 cases (39%). It was most frequently in combination with types C, D, occurring with these two together in 188 cases (31%). It does occur in combinations with solid and barred types—e. g., D^2, E^2, A, 121 times (20%), and

C^1, D^1, A, 98 times (16%)—though quite infrequently unless the combinations include also types C or D.

In 6 cases (1%) it was the only large granular type of B. diphtheriæ on the initial positive examination, and on its presence therefore the diagnosis largely hinged.

While not so frequently found in clinical cases as C or D, when it is present, it so quickly catches the eye of the observer that he is likely to render a positive diagnosis on the specimen without further morphological examination.

Type B. This type was found in but 20 cases (3%), and in every instance was associated with C or D. What significance—if any—attaches to its presence in throat cultures, is still a problem, though it would seem to be like A—an involution form of type C.

Types C and D. These two apparently closely related types occurred much more frequently than any others, i. e., C. in 403 cases (66%), and D in 509 cases (83%). They were both present in 373 cases (61%). Either one or the other, or both of them, were present in 539 cases (89%) (C 403+D 509–CD 373=C or D 539).

This means that in 89% of clinical cases a positive bacteriological diagnosis of diphtheria could be given on the presence of one or the other of these types. Their presence in such a high percentage of clinical cases coupled with their rare occurrence in the throats of well persons would seem to place them at the head of the list of types for purposes of routine diagnosis on morphological grounds. There is little choice between the two, but *it would appear a reasonable hypothesis that type D is the type par excellence of virulent Bacillus Diphtheriæ and type C is its nearest relative in one line, namely, increase in size with eccentricity of outline, while type E, its nearest relative in a second line, namely, decrease in size and greater regularity of outline, and type D^1 its nearest relative in a third line, namely variation in character of protoplasm as shown by staining reactions.*

Of these three lines A, G and D^2 may perhaps be considered terminal types in the order named. This hypothetical arrangement may be illustrated by the following diagram :

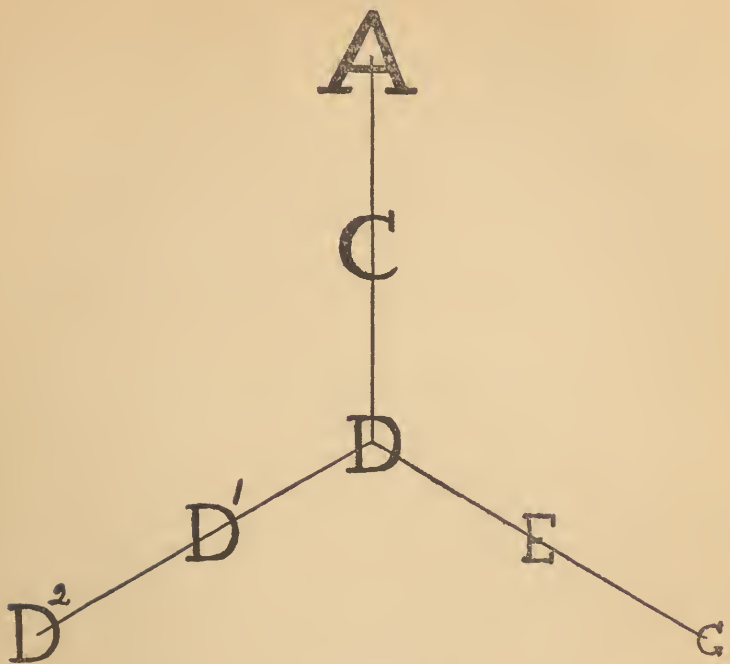

DIAGRAM A.

Diagram illustrating hypothetical variation of types of Bacillus Diphtheriæ from type D., the type most constantly present in cases of clinical diphtheria.

Type E. This type was present in 297 cases (49%). It was in combination with type D in 279 cases (46%)—or in 94% of all cases in which it was found; with types A and C—exclusive of types B and D—in 6 cases (1%), and with types F and G—exclusive of types A, B, C and D—in 12 cases (2%).

The type would thus appear to be much more closely related to type D than to any other type. Its pathogenic significance is touched on above in a discussion of the clinical cases in Group II (see page 641) in the initial examination of the 12 cases of which it was the largest diphtheria-like bacillus present.

Types F, G, A^1 and B^1. These types were found respectively in but 13 (2%), 23 (4%), 61 (10%) and 70 (11%) of the cases. These few instances furnish insufficient data from which to draw conclusions as to the diagnostic significance of the types.

Types C^1 and D^1. These types were found respectively in 170 (28%) and 197 (32%) of the cases. They occurred in 137 cases (23%), and one or the other of them was found present in 230 cases

(38%). (C^1, 170+D^1, 197–C^1 D^1, 137=C^1 or D^1, 230.) They occurred in association with C D in 144 cases (24%). They were the principal diphtheria-like bacilli present in the 19 cases discussed under "Clinical Group III," (see page 642), and in these cases were the basis for the bacteriological diagnosis given.

Types E^1, F^1 (?), A^2, B^2 and C^2. These types were found respectively in 44 (7%), 2 (0.3%), 18 (3%), 20 (3%) and 32 (5%) of the cases. In no case was a diagnosis based on any one or more of them, since in each instance they were in combination with types A, B, C, D, C^1, D^1 or D^2. Nothing therefore can be predicated concerning their diagnostic significance.

Types D^2 and E^2. These types were present respectively in 333 (55%) and 237 (39%) of the cases. They were both together in 180 cases (30%). One or the other of them occurred in 390 cases (64%), D^2, 333+E^2, 237–D^2 E^2, 180=390). They occurred more frequently with C D (206 times =34%) than with D E (170 times =28%). They occurred more frequently with A (112 times =18%), though D and E occurred much more frequently (279 cases =46%) together than did D^2 and E^2 (180 cases =30%). Either one or the other or both of these types—D^2, E^2—was present in the 32 cases discussed under "Clinical Group IV" (see page 643). In all of these they were the basis of the positive diagnosis given.

Types F^2, G^2. These types occurred respectively 20 (3%) and 27 (4%) times, always in combination with other types; hence nothing can be said of their diagnostic significance.

SUMMARY.

1. The positive bacteriological diagnoses in these 608 cases were based on the various types of B. diphtheriæ as follows:

On type A in	6 cases or	1%
On types D or C in	539 cases or	89%
On type E in	12 cases or	2%
On types C^1 or D^1 in	19 cases or	3%
On types D^2 or E^2 in	32 cases or	5%
Totals	608 cases	100%

2. Concerning the diagnostic significance of the other types nothing has been accurately determined.

3. Type D appears to be the most important from a diagnostic standpoint.

4. Type C is most frequently combined with type D.

5. Type A when found is highly diagnostic of diphtheria.

6. Types E, (D^1, C^1) and (D^2, E^2), though frequently present in the throats of well persons are, as grouped, sometimes the sole diphtheria-like bacilli present in throat cultures from cases of clinical diphtheria.

7. These types occur in a much higher percentage of individuals (throats) of all persons affected with clinical diphtheria than in individuals (throats) free from diphtheria.

8. A developmental relationship of these types with A, C or D apparently exists, of which D may be considered hypothetically the central type.

9. When symptoms or lesions of diphtheria are present, the presence of types E, D^1, G^1, D^2 or E^2 in throat culture should be sufficient evidence for isolating the patient and instituting antidiphtheritic treatment.

THE TYPES* OF B. DIPHTHERIÆ PRESENT IN THE NOSES AND THROATS OF THE INMATES OF BETHANY HOME,** MINNEAPOLIS, APRIL 9 AND MAY 14, 1900.

Had it been possible to classify the types of diphtheria and diphtheria-like bacilli in all of the special investigations here reported, comparisons could have been more easily made. The "type" classification had not been formulated nor adapted until after the completion of all the special examinations with the exception of those at Bethany Home where, however, it was employed in recording results.

GROUPS OF TYPES.

The following table shows the distribution of the three groups of types in the inmates of the Home on April 9, 1900, just after the discovery of three cases of clinical diphtheria, and on May 14, 1900, five weeks later, no new cases having developed in the meantime.

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*For plates and description of types of B. diphtheriæ, see paper "Varieties of B. diphtheriae," p. 613, this Report.
**For further particulars concerning examinations and conditions at Bethany Home, see p. 535, this Report.

TABLE NO. 31 SHOWING DISTRIBUTION OF GROUPS OF TYPES OF B. DIPHTHERIÆ IN SPECIMENS FROM INMATES OF BETHANY HOME, MINNEAPOLIS.

			First examination April 9, 1900, at the time of occurence of three cases of clinical diphtheria.						Second examination May 14, 1900, no other cases having developed in the meantime and antiseptic gargles, etc., having been employed.					
			Nose alone infected.	Throat alone infected.	Both throat and nose infected.	Total.	Total number of noses infected.	Total number of throats infected.	Nose alone infected.	Throat alone infected.	Both throat and nose infected.	Total.	Total number of noses infected.	Total number of throats infected.
1	Number of persons uninfected		....	....	....	61	....	....	....	....	....	79	....	....
2	Granular types the only diphtheria-like micro-organisms present		3	3	5	11	8	8	5	....	....	5	5	....
3	Barred types the only diphtheria-like micro-organisms present		1	1	....	2	1	1	....	....	....	....	....	....
4	Solid types the only diphtheria-like micro-organisms present		9	....	2	11	11	2	13	1	2	16	15	3
5	Mixed granular and barred types (no solid types noted)		1	1	1	3	2	2	3	1	1	5	4	2
6	Mixed granular and solid types (no barred types noted)		6	3	1	10	7	4	2	....	....	2	2	....
7	Mixed barred and solid types (no granular types noted)		8	....	....	8	8	....	5	....	....	5	5	....
8	Mixed granular, barred and solid types		4	3	....	7	4	3	3	....	....	3	3	....
9	In addition to this were combinations occurring in both throat and nose as follows:													
	NOSE.	THROAT.												
(a)	Granular and barred	Granular	....	....	1									
(b)	Granular and solid	Granular, barred and solid	....	....	1									
(c)	Granular, barred and solid	Granular	....	....	1									
(d)	Granular and solid	Granular	....	....	3									
(e)	Granular, barred and solid	Granular and barred	....	....	10	11	11	11	....	....	....	....	....	....
(f)	Granular	Granular and solid	....	....	1									
(g)	Granular and solid	Granular, barred and solid	....	....	1									
(h)	Solid	Granular and solid	....	....	1									
(i)	Barred and solid	Solid	....	....	1									
(j)	Granular	Barred and solid	....	....	....	....	....	....	....	....	2	2	2	2
			32	11	20	124	52	31	31	2	5	117	36	7

Total number of individuals infected (including all types) *first examination*, 63 (32+11+20)=51 per cent; *second examination*, 38 (31+2+5)=32 per cent.

A study of the foregoing table shows:

1. The total infection in the first examination was much greater than in the second examination, being 51 and 32 per cent, respectively.

2. The total nose infection was 42 per cent (32+20=52 individuals) in the first and 29 per cent (31+5=36 individuals) in the second examination.

3. The total throat infection was 25 per cent (11+20=31 individuals) in the first and 6 per cent (2+5=7 individuals) in the second examination.

It will therefore be seen that—

(a) Nose infection was much more common than throat infection. The contrast was particularly marked in the last examination.

(b) There was a decrease in nose infection from 42 per cent in the first to 25 per cent in the second examination.

(c) The decrease in throat infection was much more marked, i. e., from 29 to less than 6 per cent.

The thorough use of antiseptic gargles and throat sprays was perhaps responsible for the greater decrease of throat infection.

4. Granular types, either alone or mixed with barred or solid staining forms, were present in 32 per cent of the individuals in the first examination, and in 15 per cent in the second examination. The distribution was as follows:

First examination. 14 individuals showed granular types in the nose, 11 in the throat and 16 in both nose and throat, *total* 41 (or 32 per cent).

Second examination. 15 individuals showed granular types in the nose, 1 in the throat and 1 in both nose and throat, *total* 17 (or 15 per cent).

5. The decrease in infection with granular types was almost entirely confined to the throat. (See preceeding paragraph.) In other words, if throat cultures alone had been taken 14 of the 41 individuals infected with granular types on the first examination, i. e. 34 per cent would have escaped detection. In the second examination 15 of the 17 individuals or 88 per cent of those similarly infected would have been overlooked. This means that of the individuals infected with granular types 66 per cent would have been found infected in the first and only 12 per cent in the second examination (2 of the 15 individuals) had reliance been placed on examination of throat cultures alone.

Note.—In obtaining these results the combinations shown in the last items of the table must be included. In certain of them it will be seen that, although granular types are recorded in the throat, they may be absent from the nose, and vice versa.

6. Barred types occurred either alone or in mixtures in 26 individuals (17 in nose, 7 in throat and 2 in both nose and throat) in the first examination, and in 14 individuals (11 in nose, 2 in throat and 1 in both nose and throat) in the second examination. This is a decrease from 21 to 12 per cent, which was chiefly confined to the throat.

7. Solid types occurred either alone or in mixtures in 46 individuals (32 in nose, 7 in throat and 7 in both nose and throat) in the first examination, and in 28 individuals (23 in nose, 3 in throat and 2 in both nose and throat) in the second examination This is a decrease from 37 to 24 per cent, which occurred chiefly in the throat.

8. Notwithstanding this decrease in barred and solid types noted in Nos. 6 and 7, if from the total number of individuals infected with any or all types, i. e., 63 in the first and 38 in the second examination, we deduct the number who were infected with granular types, i. e., 41 in the first and 17 in the second examination, we have remaining 22 individuals in the first and 21 in the second examination who were infected with barred or solid or both groups of types, but who showed no granular types.

In other words there was practically *no* decrease in the number of individuals infected with barred or solid types or mixtures of the two if those in whom granular types were also present be excluded.

From paragraphs 4, 5, 6, 7 and 8 it will be seen that—

(a) Granular types were present more frequently in the nose than in the throat (30:27 in the first and 15:2 in the second examination).

(b) Barred types were present more frequently in the nose than in the throat (19:9 in the first and 12:3 in the second examination).

(c) Solid types were more frequently found in the nose than in the throat (39:14 in the first and 25:5 in the second examination).

(d) Total infection with granular types was nearly equal to total infection with solid types in the first examination, being present in 41 and 46 individuals, respectively.

Note.—These include for the first examination 2 individuals infected with barred types only, 11 with solid types only, 8 with mixed barred and solid types and 1 with barred and solid in the nose and solid in the throat, total 22. (Add Nos. 3, 4, 7 and 9 (i) of table.)

In the second examination are included 16 with solid types only and 5 with mixed barred and solid types, total 21. (Add Nos. 4 and 7 of table.)

(e) In the second examination the total infection with granular types was much less marked than the total infection with solid types, being present in 17 and 28 individuals, respectively.

From table No. 31 the following sub-table, showing the total distribution of the three group of types, may be made:

	First Examination.			Second Examination.		
	Individuals with *Nose* Infection	Individuals with *Throat* Infection	Total No. of Individuals Infected	Individuals with *Nose* Infection	Individuals with *Throat* Infection	Total No. of Individuals Infected
Total infection with granular types.	30 (24%)	27 (22%)	41 (33%)	16 (14%)	2 (2%)	17 (14%)
Total infection with barred types...	19 (15%)	9 (7%)	26 (21%)	12 (10%)	4 (4%)	15 (13%)
Total infection with solid types......	39 (31%)	14 (11%)	46 (37%)	26 (22%)	5 (4%)	28 (24%)

The sub-table shows that—

1. Decrease of infection was more marked in throat than in nose for each of the three groups of types, and especially so for granular types.

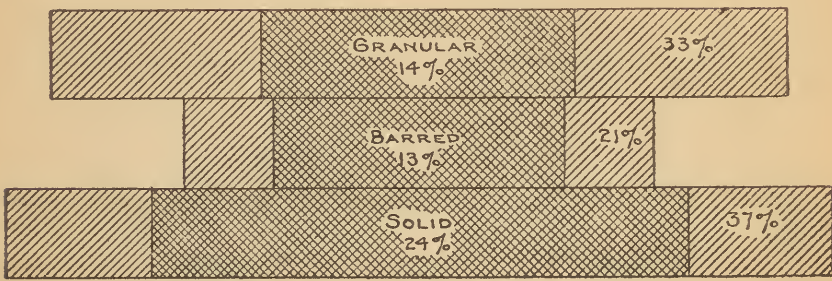
2. Decrease in total infection with granular forms was most marked, and with solid forms least marked. The general change in the morphology of the bacilli found in the second as compared with the first examination is perhaps better seen from diagram B. This diagram would seem to show that during the five weeks which elapsed between the two examinations whilst thorough treatment of the throats with antiseptics was being carried out the granular types of bacilli had tended to be replaced by barred and solid forms. In other words, in consideration of the total infection found in both examinations, though there was a decrease of all types, relatively speaking, infection with barred types had increased slightly and infection with solid types markedly.

Another fact which seems to bear on this point is that in the first examination granular types occurred as the only diphtheria-like bacilli in 11 individuals, whilst an equal number were infected only with solid types. In the second examination only 5 persons were infected with granular types alone, though 16 showed the presence of solid types as the sole diphtheria-like bacilli.

This apparent tendency to replacement of granular first by barred and later by solid types is conceivably the *modus operandi* whereby diphtheria bacilli disappear during convalescence from diphtheria, as also from the throats and noses of the ap-

parently healthy who have been brought into contact with clinical diphtheria.

DIAGRAM B.



FIRST EXAMINATION BETHANY HOME,
SECOND EXAMINATION BETHANY HOME,
(TOTAL INFECTION.)

Granular types.

1. Granular types were present in 41 individuals (33 per cent) in the first and in 17 individuals (14 per cent) in the second examination at Bethany Home, either as the only diphtheria-like organisms present or mixed with one or both of the other groups of types.

2. In 38 of the 41 individuals thus infected in the first and in all the 17 thus infected in the second examination, the types A, B, C or D were present, that is of the individuals infected with granular types, 93 per cent in the first and 100 per cent in the second examination showed the presence of types A, B, C or D, those which may be looked upon usually as characteristic of clinical diphtheria.

3. In 16 of the 38 individuals in the first and in only 2 of the 17 individuals in the second examination who were infected with types A, B, C or D, the diphtheria and diphtheria-like bacilli were practically in pure culture, i. e., other micro-organisms were so few as to be unnoticeable.

4. The granular types were the only forms of diphtheria and diphtheria-like bacilli present in 11 individuals in the first and in 5 individuals in the second examination.

In the first examination they were distributed as follows:

In 3 persons present in the nose alone, their throats being free of all diphtheria and diphtheria-like bacilli. In 3 persons present in the throat alone, the nose being free of all suspicious forms. In 5 persons present in both nose and throat.

In the second examination they were present in all 5 individuals in the nose alone, the throat being free of all suspicious forms.

5. Granular types were present either alone or mixed with other types in the noses of 30 individuals in the first and 16 individuals in the second examination, in the throats of 27 in the first and 3 in the second examination and common to both throat and nose in 16 individuals in the first and 3 in the second examination.

It will thus be seen that—

1. Such granular types as D, C, A or B, the most representative types found in clinical cases, were present in both examinations.

2. Granular types were not only present much more frequently in the first examination, but were also more frequently present in practically pure culture. This means that in the second examination granular types had disappeared entirely from many individuals—from the throats of all but 2 individuals—and that where they were still present, they were numerically not so conspicuous in the second as in the first examination.

Barred Types.

1. Barred types were present in 26 individuals (21 per cent) in the first, and in 15 individuals (13 per cent) in the second examination.

2. Barred types occurred as the only diphtheria-like bacilli only twice in the first examination (once in the nose and once in the throat) and not at all in the second examination.

3. Barred types were present more frequently in the nose.

4. The most important barred type present in both examinations was D^1.

Solid Types.

1. Solid types occurred in 46 individuals (37 per cent) in the first and in 26 individuals (22 per cent) in the second examination.

2. Solid types were found as the only diphtheria-like organisms in 11 persons in the first examination (11 noses and 2 throats) and in 16 individuals in the second examination (15 noses and 3 throats).

3. Solid types occurred with relative infrequency in the throat.

4. The most important solid types were D^2 and E^2.

The following table shows the frequency of occurrence of the various types of diphtheria and diphtheria-like bacilli and their location in nose or throat, or both in the inmates of Bethany

Home, Minneapolis. It supplements table No. 31, p. 651, in which the grouping of types was partially shown.

INDIVIDUAL TYPES.

Table No. 32, showing frequency of occurrence and the site of individual types of B. diphtheriæ in the inmates of Bethany Home, Minneapolis.

Type of Diphtheria-like Bacillus Present in	1st Examination of 124 Individuals, April 9, 1900, just after Discovery of 3 Cases of Clinical Diphtheria. 63 Individuals showed One or More Types of B. Diphtheriæ Present in Nose or Throat, or Both.						2d Examination of 117 Individuals, May 14, 1900, no New Cases having Occurred in the Meantime. 36 Individuals Showed One or More Types of B. Diphtheriæ in Nose or Throat, or Both.					
	Nose Only.	Throat Only.	Both Nose and Throat	Total No. of Individuals Inf't'd.	Total No. of Noses Infected.	Total No. of Thr'ts Infected.	Nose Only.	Throat Only.	Both Nose and Throat	Total No. of Individuals Inf't'd.	Total No. of Noses Infected.	Total No. of Thr'ts Infected.
A	5	9	5	19	10	14	5	0	1	6	6	1
B	2	0	0	2	2	0	1	0	0	1	1	0
C	4	11	7	22	11	18	9	1	1	11	10	2
D	10	12	11	33	21	23	15	1	1	17	16	2
E	6	10	6	22	12	16	8	1	1	10	9	2
F	2	1	0	3	2	1	1	0	0	1	1	0
G	2	0	0	2	2	0	0	0	0	0	0	0
A^1	0	0	0	0	0	0	0	0	0	0	0	0
B^1	11	3	1	15	12	4	0	0	0	0	0	0
C^1	0	0	0	0	0	0	2	2	1	5	3	3
D^1	14	7	1	22	15	8	8	0	1	9	9	1
E^1	0	0	0	0	0	0	1	0	0	1	1	0
F^1	......	......	......	......	......	......	......	......	......	......	......	......
G^1	......	......	......	......	......	......	......	......	......	......	......	......
A^2	0	0	0	0	0	0	0	0	0	0	0	0
B^2	2	0	0	2	2	0	2	1	0	3	2	1
C^2	1	0	0	1	1	0	0	1	0	1	0	1
D^2	26	5	4	35	30	9	21	3	1	25	22	4
E^2	23	5	1	29	24	6	22	3	1	26	23	4
F^2	0	0	0	0	0	0	0	0	0	0	0	0
G^2	5	1	1	7	6	2	0	0	1	1	1	1

NOTE.—F^1 and G^1 have never yet been observed, but spaces were left in the classification when it was formulated for *barred* types of the dimensions of F and G in case they should be met with and facilities for their study and classification be at hand.

From table No. 32 it is possible to make the following sub-table:

Sub-Table No. 33, showing types of diphtheria and diphtheria-like bacilli found in the inmates of Bethany Home arranged in the order of the frequency of their occurrence.

(Bracketed letters show that such types were found an equal number of times. All letters below the cross lines indicate that these types were not present.)

Order of Frequency of Occurrence in *Nose*. (Includes Infection of Nose Alone as Well as Infection of Both Nose and Throat.)		Order of Frequency of Occurrence in *Throat*. (Includes Infection of Throat Alone as Well as Infection of Both Nose and Throat.)	
First Examination. 124 Persons.	Second Examination. 117 Persons.	First Examination. 124 Persons.	Second Examination. 117 Persons.
D^2 (30 times)	E^2 (23 times)	D (23 times)	D^2, E^2 (four times).
E^2 (24 times)	D^2 (22 times)	C (18 times)	C^1 (three times).
D (21 times)	D (17 times)	E (16 times)	C, D, E (twice).
D^1 (15 times)	C (10 times)	A (14 times)	A, D^1, B^2, C^2, G^2 (once).
E, B^1 (12 times)	E, D^1 (9 times)	D^2 (9 times)	
C (11 times)	A (6 times)	D^1 (8 times)	
A (10 times)	C^1 (3 times)	E^2 (6 times)	
G^2 (6 times)	B^2 (twice)	B^1 (4 times)	
B, F, G, B^2 (twice)	B, F, E^1, G^2 (once)	G^2 (twice)	
C^2 (once)		F (once)	
———	———	———	———
A^1	G	B	B.
C^1	A^1	G	F.
E^1	B^1	A^1	G.
A^2	A^2	C^1	A^1.
F^2	C^2	E^1	B^1.
	F^2	A^2	E^1.
		B^2	A^2.
		C^2	F^2.
		F^2	

TABLE No. 34,

Showing occurrence of three of the more frequent combinations of types in the examinations at Bethany Home.

AT BETHANY HOME.	Nose Alone.	Throat Alone.	Common to Both.	Total No. of Persons Infected.
C and D in combination, first examination ..	4	11	6	21
C and D in combination, second examination	8	1	1	10
D and E in combination, first examination ..	4	10	5	19
D and E in combination, second examination	7	1	1	9
D^2 and E^2 in combination, first examination ..	14	4	1	19
D^2 and E^2 in combination, second examination	19	3	1	23

From tables No. 32 and 33 it is possible to make the following statements concerning the occurrence of the individual types found on the two examinations at Bethany Home.

Type A. This type occurred in 19 individuals in the first and in 6 individuals in the second examination. Its presence in a culture from a clinical case is perhaps more suggestive of a diagnosis of diphtheria than even that of C or D, and it is therefore

Note.—Much stress cannot be laid upon the order of frequency of occurrence where infection with any of the types is not marked e. g. in the last column of the subtable no type was present in more than four of the 117 throats examined.

not surprising that it should be much more prominent in the first examination shortly after the discovery of the three clinical cases than five weeks later. It will be noted that it occurred more frequently in the throat in the first and more frequently in the nose in the second examination.

Type B. This type occurred in only 2 individuals in the first and 1 in the second examination, being in the nose in each instance.

Types C and D. C occurred in combination with D 21 times in the first and 10 times in the second examination, that is to say it was present unassociated with D only once in each examination, in both instances being in nose cultures. Type D occurred unassociated with C in 12 individuals in the first and in 8 individu-in the second examination. It will be seen that types C and D like types A and E occurred more frequently in the throat in the first and more frequently in the nose in the second examination.

Types D, C, E and A in the order given, were the granular organisms most frequently present in the throat cultures of the first examination which, owing to the occurrence of three cases of clinical diphtheria in the institution, approximated to the conditions obtaining in routine examinations of clinlcal cases.

In the second examination the same order prevailed for these types, though they were overshadowed by types D^2 and E^2.

They (C and D) were present in combination in 21 of the 41 individuals in whom any granular types were found in the first and in 10 of the 17 in the second examination. D was present in 33 of the 41 infected with granular types in the first and in all of the 17 in the second.

Type E was found associated with D in 19 of the 22 individuals in which E occurred in the first examination and in 9 of the 10 individuals in which it occurred in the second examination.

It was found more frequently in the throat in the first and in the nose in the second examination.

Type F occurred in only 3 individuals in the first and in 1 individual in the second examination, being present only once in the throat when it was also present in the nose.

Type G occurred in only 2 individuals (nose only) in the first and was absent altogether in the second examination.

Type A^1 was absent in both examinations.

Type B^1 was present in 15 persons (chiefly in the nose) in the first examination and absent altogether in the second examination.

Type C^1 was absent altogether in the first and present in 3 individuals (equally distributed in nose and throat) in the second examination.

Type D^1 was present in 22 individuals (15 noses and 8 throats being infected) in the first examination and in 9 individuals (9 noses and 1 throat) in the second examination. This type, the nearest relative to D, in one direction may be taken as the principal representative of the barred types. It was more prevalent in the nose therein differing from C and D in the first examination.

Too much stress must not be laid on the differences between B^1 and C^1 in these examinations, and it is probable that they should be considered together in order to obtain a fair idea of the results, since some confusion in their tabulation in the record may have occurred.

Type E^1 was observed but once, namely in the nose in the second examination. Owing to its size and markings it is difficult to distinguish it from E^2.

Types F^1 *and* G^1 were not observed.

Type A^2 was not observed.

Type B^2 was found in 2 individuals in the first and in 3 in the second examination. It was more frequent in the nose.

Type C^2 was present in the nose of 1 individual in the first and in the throat of 1 individual in the second examination.

Types D^2 *and* E^2 are those which have come to be looked upon as the diphtheria-like bacilli most frequently found in well people, and are especially abundant in the nose. D^2 was associated with E^2 in 19 of the 29 persons infected with E^2 in the first, and in 23 of the 26 individuals similarly infected in the second examination.

They were confined chiefly to the nose cultures in both examinations, and whilst they are therefore the most important types in the consideration of total infection for both examinations, they were relatively inconspicuous in the throat cultures of the first examination, though the most abundant types in the throat cultures in the second examination.

The importance of these, as compared with other types in the throat in these examinations and in clinical diphtheria, will be considered later.

Type F^2 was unobserved.

Type G^2 was much more abundant (7 individuals—6 noses and 2 throats) in the first than in the second examination (1 individual, both nose and throat).

SUMMARY OF OCCURRENCE OF TYPES IN BOTH EXAMINATIONS AT BETHANY HOME.

1. A somewhat greater variety of types was observed in the nose than in the throat in both examinations.

2. *Types D, C, E and A* in the order given were the chief representatives of the granular types in both examinations, in this respect resembling the findings in clinical diphtheria.

3. These granular types were slightly more abundant in the throat in the first and in the nose in the second examination. The occurence, however, of types B, F and G, principally in the nose, made the total infection with all granular types more abundant in the nose than in the throat in the first examination.

4. *Types D and C* appear here as in clinical cases to be the most frequent and important representatives of the group.

5. *Type E* was so rarely found unassociated with D or C as to appear unworthy of individual consideration.

6. *Types F and G* occurred so rarely as to obviate necessity of discussion. They seemed to be mostly confined to the nose.

7. The chief representatives of the barred types seem to be D^1 and C^1, the nearest neighbors in this group to D and C, which are the most important members of the granular group.

8. The other members of this group need not be considered. In general it may be stated that the barred types were inhabitants of the nose rather than of the throat, though not so marked in this particular as the solid types.

9. Types D^2 and E^2 should perhaps be considered together, and as such may be looked upon as the most important representatives of the solid group. They were met with much more frequently in nose cultures, therefore in the first examination where throat infection was much more marked, they did not assume the important place that they occupied in the second examination, where they completely overshadow all other types.

10. The results of examination in these two investigations more nearly resemble those of clinical cases than of well people. This is especially true of the first investigation which was begun because of the occurrence of clinical diphtheria in 3 cases.*

---

*Since this investigation was completed, Bethany Home has been again examined (July, 1901) and though no diphtheria had been reported since April, 1900, the results as compared with results of similar examinations elsewhere confirmed the impression that infection in this institution more nearly resembles that found in clinical cases than in any other examination of well people hitherto undertaken.

TYPES OF B. DIPHTHERIÆ AT BETHANY HOME COMPARED WITH THOSE IN CLINICAL CASES AND ELSEWHERE.

From earlier similar investigations it is impossible to obtain data strictly comparable with that tabulated for Bethany Home, since the "type" method of classification was not then in use. In general it may be stated that—

(a) The percentage of granular types present on the first examination at Bethany Home was greater than that found in any other group of well individuals, and even on the second examination it was still higher than the average.

(b) The percentage of infection with barred and solid types was lower than that found in similar investigations, except in one instance (Albert Lea, p. 522, this report).

It is apparent therefore that comparison of the types found at Bethany Home with those found in clinical cases does not give an absolutely correct conception of the relation of the types found in normal well persons to those occurring in clinical cases. The results of the second examination at Bethany Home more nearly approach those hitherto found in well people. The error present, however, is that of showing too little, rather than too great, a difference between the findings in well persons and in clinical diphtheria. Furthermore, too few individuals were examined to serve as the basis of final conclusions. Since throat cultures alone were taken in the clinical cases, only the results of the throat examinations made at Bethany Home may be compared with them.

A comparison of results is possible from diagrams C, D and E, which show the distribution of the granular, barred and solid groups of types in the throat in both examinations at Bethany Home and in 608 clinical cases.

It will be seen that the general form of the diagram for the first examination at Bethany Home much more nearly resembles that for the clinical cases than either one resembles the diagram for the second examination of Bethany Home.

Whether a comparison of similar diagrams for examination of institutions or groups of individuals would render assistance in determining the probability of recent exposure to clinical diphtheria is yet to be determined.

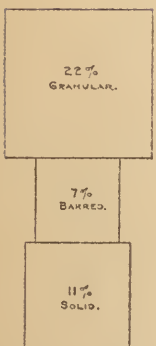


DIAGRAM C.
First Examination,
Bethany Home.
(Throat Infection.)

DIAGRAM D.
Second Examination,
Bethany Home.
(Throat Infection.)

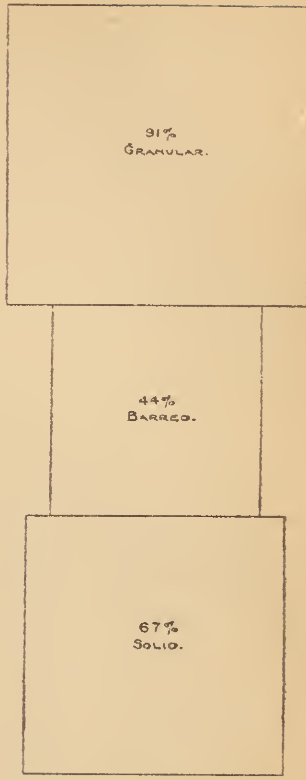


DIAGRAM E.
608 Clinical Cases.
(Throat Infection.)

Table No. 35 showing percentage frequency of occurrence of the various types of B. diphtheriæ in the throats of 124 individuals. FIRST EXAMINATION at Bethany Home.

Type	A	B	C	D	E	F	G
Percentage of occurrence	11	0	14	19	13	1	0
Type	A¹	B¹	C¹	D¹	E¹	....	....
Percentage of occurrence	0	3	0	7	0	....	....
Type	A²	B²	C²	D²	E²	F²	G²
Percentage of occurrence	0	0	0	7	5	0	2

Table No. 36 showing percentage frequency of occurrence of the various types of B. diphtheriæ in the throats of 117 individuals. SECOND EXAMINATION at Bethany Home.

Type	A	B	C	D	E	F	G
Percentage of occurrence	1	0	2	2	2	0	0
Type	A^1	B^1	C^1	D^1	E^1	....	....
Percentage of occurrence	0	0	0	3	1	....	....
Type	A^2	B^2	C^2	D^2	E^2	F^2	G^2
Percentage of occurrence	0	1	1	4	4	0	1

Table No. 37 showing percentage frequency of occurrence of the various types of B. diphtheriæ in the first positive examination of each of 608 individuals in which diphtheria was diagnosed. (Routine examinations.)

Type	A	B	C	D	E	F	G
Percentage of occurrence	39	3	66	83	49	2	4
Type	A^1	B^1	C^1	D^1	E^1	F^1 (?)	G^1 (?)
Percentage of occurrence	10	11	28	32	7	0.3	0
Type	A^2	B^2	C^2	D^2	E^2	F^2	G^2
Percentage of occurrence	3	3	5	55	39	3	4

A comparison of tables 36 and 37 bears out the inference that the findings in the throat and also the conditions at Bethany Home on first examination were more nearly like those in clinical cases than were those on the second examination.

In addition the following may be seen:

1. The clinical cases show greater variety in morphological types possibly due to the fact that more examinations were made.

2. In the clinical cases the percentage frequency of occurrence of the granular types A, C, D and E and the barred type D^1 is about four times greater than it is in the first examination at Bethany Home, whilst for the solid types D^2 and E^2 it is about eight times. *This means a greater proportionate occurrence of these solid types in the throats of the clinical cases.*

3. In obtaining an idea of what types have seldom or never a causative relation to clinical diphtheria, i. e., are saprophytic, it might perhaps be expected that such types would be present in the throats of well people, even in greater percentage abundance than in clinical cases.

Applying this test to certain types, it is seen that D^2 and E^2 ("pseudo-diphtheria bacillus") are not only actually but relatively much more abundant in clinical cases. So also are the small granular types F and G and the barred types, A^1, B^1, C^1, E^1. This would tend to show that these types have some relation to clinical diphtheria.

THE ROLE OF THE VARIOUS TYPES OF B. DIPHTHERIÆ.

I. *Granular Types.*

1. Type D is the most important from a diagnostic standpoint occurring as it does in the greatest number of cases of diphtheria.
2. Types C, E and A are next in order of importance, though type E is perhaps the least significant.
3. Types B, F and G occurred very infrequently and never except in association with better recognized types. Any statement concerning their pathogenic importance is therefore unwarranted.
4. Occasionally types of this group are found in the noses and throats of well people, seemingly being more abundant in those recently exposed to clinical diphtheria.
5. In well people the order of frequency of occurrence is identical with that in clinical cases, viz., D, C, E, A, so far as the examinations at Bethany Home may be taken as evidence.
6. The examinations for Bethany Home are too few to warrant the drawing of final conclusions. From these, however, it would appear that the granular types disappeared from the inmates of the Home earlier from the throat than from the nose.
7. The total decrease of granular types was much greater than that of the solid and slightly greater than that of the barred types.

II. *Barred Types.*

1. Types D^1 and C^1 are the most important from a diagnostic standpoint having been used as the basis of a diagnosis in 3 per cent of the clinical cases.
2. Types A^1, B^1, E^1, F^1(?) occurred too infrequently to warrant drawing any conclusions as to their clinical significance.
3. There is no evidence in these studies to show that barred types are more closely related to clinical diphtheria than are the solid types, though such an assumption is frequently made.

III. *Solid Types.*

Types A^2, B^2, C^2, F^2 and G^2 need not be here considered, since the available evidence as furnished by the examination at Bethany Home and in the clinical cases is insufficient to warrant making any definite statements at this time concerning their diagnostic significance.

D^2, E^2. The role of these types in clinical diphtheria has been long under discussion. The following is a summary of the evidence for and against the assumption that they are mere saprophytes.

Evidence tending to show that Types D^2 and E^2 are saprophytes, having no causative relation to diphtheria.	Evidence tending to show that types D^2 and E^2 are varieties of B. diphtheriae and do cause clinical diphtheria.
I. D^2 and E^2 are abundant in the noses (25 to 38%) and fairly frequent in the throats (7 to 16%) of well persons.	I. Types D^2 and E^2 are more abundant in the throats of diphtheria patients than in healthy throats (55 to 16%). No data is at hand concerning their occurrence in noses in clinical cases. They are, however, more abundant in the throats of diphtheria patients than in the noses of well people (55 to 25-38%). Granular types, D, C, E and A are occasionally found in the throats and noses of well persons, and more frequently in the throats and noses of those recently exposed to diphtheria.
II. (1) D^2 and E^2 are more stable types than granular types C and D, i. e. more rarely vary to other types.	II. (1) D^2 and E^2 sometimes do vary to types D and E in what appear to be pure cultures; while types C, D and E vary frequently to types D^2 and E^2. * * * By passage through small birds and guinea pigs, types D^2 and E^2 may be changed apparently into short, and later into long, granular types.*
(2) They frequently grow more abundantly on artificial media.	(2) Pure cultures of granular types (C, D, E and A) vary greatly in regard to growth.
(3) Types D^2 and E^2 develop more rapidly at low temperatures.	(3) Granular types vary greatly in this regard.
(4) Types D^2 and E^2 frequently do not produce acid in glucose media.	(4) Granular types (C, D, E and A) vary greatly in acid production. Acid production may be developed in D^2 and E^2 by passage through small birds.*

*Salter: "Transactions of the Jenner Institute of Preventive Medicine." Second Series, 1899, page 113.
***Wesbrook, Wilson, McDaniel: "Varieties of Bacillus Diphtheriæ." Transactions of the Association of American Physicians, 1900.

III. Types D^2 and E^2 are usually not virulent for guinea pigs.	III. D^2 and E^2 are occasionally virulent for guinea pigs, and when virulent may be protected against by commercial antitoxine.** When D^2 and E^2 are not virulent, by passage through birds, they may become virulent for guinea pigs.* The granular types C, D, E and A are frequently not virulent for guinea pigs.
IV. Few cases of clinical diphtheria occur without the presence of granular types (D, C, E, A).	IV. In a small percentage of clinical cases (2% of above series) D^2 and E^2 are the sole discoverable diphtheria-like organisms. Such cases respond to antitoxine. In one case, in which death ensued on the third day, D^2 and E^2 were the sole diphtheria-like organisms discoverable in a culture taken the second day of the disease while a membrane was present. (See page 643, this report.)

*Salter: "Transactions of the Jenner Institute of Preventive Medicine." Second Series, 1899, page 113.

**Wesbrook, Wilson, McDaniel, Adair: "A Preliminary Communication on Bacillus Diphtheriæ and Its Variants in a School in which Diphtheria was Endemic." British Medical Journal, April 16, 1898.

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